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JAN 23 1883

[REGISTERED AT THE GENERAL POST OFFICE AS A NEWSPAPER.

VOL. XII.
No. CCLXVII.]

JANUARY 6, 1883.

[PRICE FOURPENCE.

THE ELECTRICAL REVIEW

LONDON: PUBLISHING OFFICE, 22, PATERNOSTER ROW, E.C.
NEW YORK: D. VAN NOSTRAND, 23, Murray Street, and 27, Warren Street. PARIS: Madame VEUVE J. BOYVEAU, Librairie Étrangère, 22, Rue de la Banque. BERLIN: A. ASHER & Co., 5, Unter den Linden.

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THE TELEGRAPHIC JOURNAL AND
Electrical Review.
VOL. XII.—No. 267.

THE ELECTRIC LIGHTING ACT.

OUR readers are aware that, according to the recent Electric Lighting Act, the Board of Trade has power to authorise by *Provisional Order* any local authority, company, &c., to supply conditionally electricity over a defined area. These Orders however do not come into force unless confirmed by Act of Parliament, and applicants for such Orders are bound to give notice to the local authorities of intention to apply. We have been favoured with several copies of "Draft Provisional Orders" drawn up for town and country districts by one of our most able men, both legally and scientifically speaking.

The Electric Lighting Act itself might be compared to a shell of which these *Provisional Orders* form the contents, or, in other words, these latter contain definite information as to what is to be done in the present stage of electric lighting, and rules and regulations for the carrying out of such an object. The gentleman responsible for the framing of these Orders has endeavoured to act impartially to all parties concerned, and he has certainly attained his desire as far as we may judge by a first reading.

The matter has evidently been very carefully considered, and it is easy to perceive that although the draftsman's legal knowledge has the ascendency, the scientific details of the subject, allowing for some little electrical eccentricities, may be called more than creditable. Indeed we believe that the engineers of all or nearly all the electric lighting companies had no fault to find with any of the provisions set forth in the Orders. Presuming that the case had been otherwise we doubt not but that Mr. Fletcher Moulton, F.R.S., the gentleman in question, could have easily met any such opposition to his views.

There are many points in Mr. Moulton's production of the greatest interest to everybody at all concerned with the future developments of electrical science, for although it is only framed in such a way as to be but an elaborate model on which to base such further provisions as may be necessary, it contains much that is worthy of comment and criticism, and much that by expanding may be made more easily understood by the general public. This week, however, we have not sufficient space at our command to enable us to touch upon any portions, as we had thought of doing. In the meantime those of our readers who desire it can, we believe, obtain a copy of any of those *Provisional Orders* which have yet been or are to be applied for, from Messrs. Walter Webb & Co., of 23, Queen Victoria Street, and by so doing we can assure them that they will find much to make clear the way for the immediate employment of the electric light for ordinary and general uses.

THE JABLOCHKOFF ELECTRIC LIGHT.—The Jablochkoff Company has received a letter from Messrs. Harrison, Ainslie & Co., stating that the illumination of their mines by the above system is eminently satisfactory.

THE TELEPHONE AND THE SPEAKING TELEPHONE AS A SCIENTIFIC INVENTION, AND ITS COMMERCIAL POSITION.

[A CONTRIBUTION.]

IN the Annual Reports of the Physical Society of Frankfort of 1860-61, we find published a lecture by Reis, in which he said "While pursuing my studies of the organ of hearing, I succeeded in the construction of an apparatus with which sounds could be sent to distant places with the assistance of the galvanic currents, and could be reproduced. I gave to the instrument the name 'das Telephon.'"

The Natural Philosophical Society of Giessen and the University of Hesse Darmstadt complimented Mr. Reis on this invention.

This appears to be the first reliable evidence that "sounds could be sent to distant places with the assistance of the galvanic current, and could be reproduced."

The Reis telephone consisted of an instrument by which undulatory currents of electricity can be produced in a closed circuit, which instrument may be called the transmitter; it has been said empirically that this transmitter did not work with a closed circuit, but with a broken circuit, and therefore did not act as a tension regulator. An examination and trial of the instrument proved conclusively that it does act as a tension regulator, and further, that articulate speech can be reproduced in any good receiver when this instrument is used for transmitting. This instrument has a diaphragm with contact points provided with a spring and an adjusting screw; the contact points are made of metal, one of them being attached to the diaphragm, and the other to a spring, the initial pressure of the contact being determined by a screw. The pressure of the electrodes at the contact point is more or less according to the vibrations of the diaphragm; and the electric current from the battery rises in tension as the pressure on the contact points increases, and lessens as the pressure diminishes. It is by no means necessary that the contact points in a tension regulator should be of a material of low conductivity.

The Reis transmitter differs from the Edison transmitter only in *one* thing, namely, in the material of the contact points. Edison used "lampblack or a fibre such as particles of silk rubbed with plumbago or soft metal," this material being squeezed between the diaphragm and the spring. In the same way does the Reis transmitter work, and it is an instrument capable of producing a rise and fall of electric tension in a closed circuit, according to the vibrations of the diaphragm. There is no doubt that the variations of the tensions of the current are greater with contact points of a material of low conductivity than with one of high conductivity. Can it be denied that the transmitter of Reis was the combination of a diaphragm with a tension regulator.

The other part of Reis's telephone is the receiving instrument, or, to name it more correctly, the sound-reproducing instrument. This instrument consists of an electro-magnet made so by a current passing through the coils on it from the line-wire, with a bar or plate armature in front of, but not capable of coming in contact with, the poles of the magnet; the vibrations of which armature are communicated to a sounding box through a metallic bar attached to it, the other end of the bar being attached to one end of the armature. These two instruments when connected together by metallic conductors—in the circuit of which is placed a battery—operate as follows: When air-waves fall upon the diaphragm of the transmitting instrument a rise and fall of the tension of the electric current results from the greater or less intimacy of surface contact of the electrodes; and the magnetic force of the electro-magnet at the other end of the circuit varies with the rise and fall of the tension of the electric current, and the armature in front of the electro-magnet vibrates in accord with the variations of the magnetic force of the magnet, and these vibrations of the armature are communicated to the sounding box. It is not denied by any one that these combined instruments of Reis reproduced musical sounds at a distance with the assistance of galvanic currents, and can any one refuse to accord to Reis, the poor artisan of Frankfort, the honour of having invented the telephone?

It is said his telephone was only capable of reproducing musical notes, and that it was incapable of reproducing articulate speech. Several eminent electricians have given opinions that the Reis telephone, that is, the Reis transmitter and the Reis receiver could not successfully reproduce articulate speech. Are *opinions* of experts to outweigh the positive statements of other scientific men—that the Reis telephone does reproduce articulate speech? It has been urged that the reproduction of articulate speech by the Reis instrument was not obtained until after Prof. Bell's instrument had been made public. Let it be assumed that such is the fact. Yet, if the *original* Reis instrument, without any alteration whatever, speaks now, does it not remain an indisputable fact that Reis was the original inventor of a speaking telephone. It has been urged that the information obtained from the construction and working of the Bell telephone enables persons to obtain articulate speech from the Reis telephones; also that, if the transmitter were spoken to in a loud tone, there would be makes and breaks of the circuit, and consequently intermittent currents, and not undulatory currents, which are necessary to reproduce articulate speech, would be produced.

Did Reis give instructions that persons using his instruments should yell into them at the top of their voices, thereby to render them useless? As well might it be said that the Armstrong gun cannot throw a shot to a great distance if it be charged with powder so as to burst it. There is evidence, however, that the Reis instrument did reproduce articulate speech in 1862, and this fact is sworn to by Mr. J. Wilhelm Albert, an agent of Reis, of Frankfort. Can it be denied that Reis was the first inventor of an instrument for producing undulatory currents in a closed circuit? Can it be denied that Reis was the first to use undulatory currents to reproduce sounds with the assistance of the galvanic battery? Can it be denied that Reis was the first to invent an instrument which reproduced articulate speech?

It is one thing to make a great discovery, and quite another thing to utilise it and make it commercially successful. Reis, the poor artisan, without having himself realised the greatness of his invention, died poor as he had lived, in 1874, and a few years after Prof. Bell had the good fortune to announce to the world his speaking telephone, in which the principles of the Reis receiver are found in an instrument in which the bar armature of the Reis is changed into a circular armature. The instrument of Prof. Bell was exhibited at the Centennial Exhibition in Philadelphia, in July, 1876, when Sir William Thomson and other eminent scientists heard it *faintly* repeat a few monosyllables. "To be, or not to be," "There's the rub." This instrument was an electro-magnet with an iron cylinder around it, with an iron plate attached at one point only of the cylinder, and tilted at a certain angle from the plane of the top of the cylinder. Sir William Thomson brought one of these instruments to Glasgow, and has "asserted that neither himself nor his assistants could make anything of them." "They were obviously not practically useful instruments, and it was obvious a new invention was necessary before they could be so, because of the exceeding difficulty I had in hearing the words at Philadelphia, and then only when the tilted armature was held pressed down by the ear." In this instrument the vibration of the armature is that of a tongue as in the Reis' instrument; but in this latter the vibratory movement of the armature occasioned a tympanic movement in the sounding board, and it is this tympanic vibration which reproduced speech; whereas the armature of this Bell instrument, evidently enlarged for the purpose of obtaining a greater area of vibrations of the air, fails to reproduce speech.

Such was the instrument for reproducing speech made by Prof. Bell prior to December 9, 1876—the date of his English patent. In the words of Sir William Thomson—"the most important part of this last invention was the substitution for the disc held at one point of a disc held all round its edge." A very slight change, but an all-important one; and this change was the obvious result of the reproduction of speech having been obtained when the tilted disc was pressed down by the ear, thereby preventing any tongue vibrations of the disc armature, at the same time leaving to it tympanic vibrations.

It seems unnecessary to say much of the use Prof. Bell made of this same instrument as a transmitter, because he simply used a well-known discovery of Faraday, and, moreover, as a transmitting instrument it has never worked successfully.

Prof. Bell's first patent for instruments supposed by some to transmit and reproduce articulate speech was filed in the United States Patent Office on February 13, 1876, for "improvements in telegraphy," and the specification describes his method of transmitting signals by means of musical notes, but does not speak of transmitting articulate speech; and it is well known the instruments therein described did not reproduce articulate speech, and Prof. Bell himself says, "the gold-beater-skin instrument is of small utility, owing to its uncertainty of action."

It is then an undisputed fact that prior to December 9, 1876, Prof. Bell had not invented instruments which could reproduce successfully articulate speech. There is in the Records of the Patent Office of the United States a full description, accompanied by drawings, of a transmitting instrument and a receiving instrument filed by a Mr. McDonough on April 10, 1876. The transmitter is made on the same principles and almost in the same manner as that of Reis; but the receiver consists of a parchment stretched over a drum-head attached to a board; in the centre of the parchment is secured a disc of iron, and in front of, close to this disc are the poles of an electro-magnet, the coils upon which are in the circuit of the line-wires, the battery, and the transmitter. These instruments reproduce perfectly articulate speech; and when this receiver is used with a Hughes' microphone and induction coil the articulation is perfect, the tone full and loud, and it is entirely free from the disagreeable buzzing sound almost constantly found in receivers when an iron disc is used. Here then is a practical receiver made on April 10, 1876, whereas Bell's receiver dates from December 9, 1876.

On January 30, 1877, Prof. Bell applied to the United States Patent Office for a patent for his invention described in his English patent of December 9, 1876; and, strange to say, one of the drawings in this United States patent is a fac-simile of the drawing, above described, in Mr. McDonough's application of April 10, 1876.

The name of Prof. Hughes has been incidentally mentioned above, but any remarks about the telephone would be incomplete without giving to that eminent scientist—that lover of science—the credit of having discovered the peculiar properties of carbon which render it so efficient in the microphone, an invention of the same eminent electrician.

"*Palmam qui meruit ferat.*"

The length of these remarks renders it necessary to defer to next week that portion which relates to the telephone commercially.

Das Telephon.

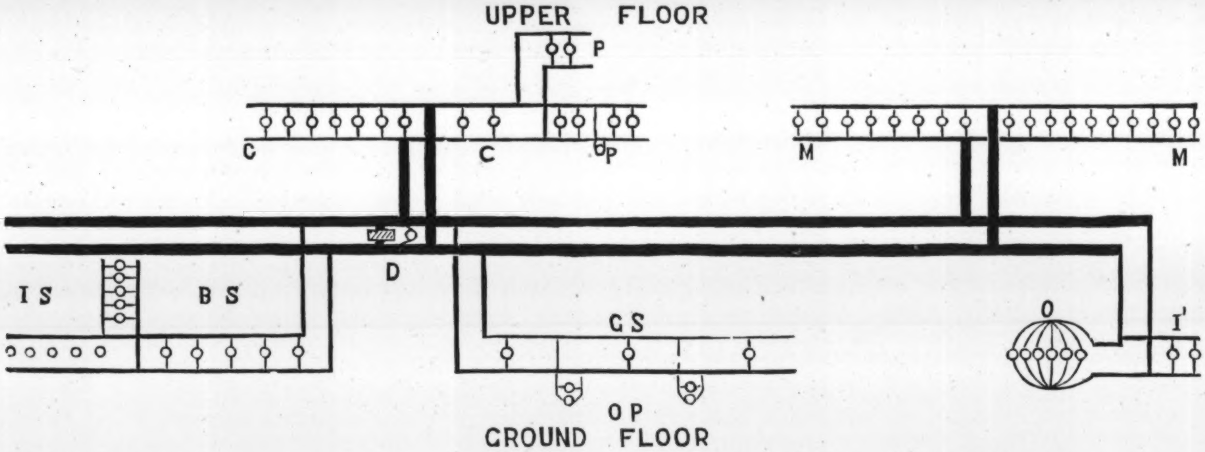
Electrical Engineering.—Prof. W. Grylls Adams, F.R.S., will deliver a course of lectures on Voltaic and Dynamic Electricity and Magnetism, and their applications to cable-testing, electric lighting, &c., during the ensuing session. A course of practical work in electrical testing and measurement, with especial reference to electrical engineering, will also be carried on under his direction in the Wheatstone Laboratory. The lectures will be given once a week on Mondays at 2 p.m., and the laboratory will be open daily (Saturday excepted) from one to four. The work will begin on Monday, January 15th, 1883. For further particulars apply to Prof. Adams, King's College, London.

Lewis's Patent Self-binding Insulator.—We understand that Messrs. Doulton & Co., Buller & Co., Bourne & Son, and Stiff & Son, are providing themselves with the necessary special machinery for producing this insulator in large quantities, and that, so far as regards the United Kingdom, the manufacturing of it will be limited to them. Mr. Lewis will be represented in London by several of the leading telegraph engineering firms. Some scores of trial orders have been received already, both for home and abroad, and there is every prospect of the insulator coming into universal adoption.

ELECTRIC LIGHT ILLUMINATION AT MIDLAND RAILWAY COMPANY'S TELEGRAPH STORES AND WORKSHOPS, DERBY.

SINCE September last the electric light has been employed for the illumination of the stores and workshops attached to the telegraph department of the Midland railway system at Derby. The Swan incandescent light is adopted, and the gas lights formerly in use have been in each instance replaced by one of these lamps of 16 candle-power. The dynamo employed is one of Siemens' latest shunt machines of 60 light-power. It is driven by a small vertical four horse-power (nominal) engine, fed from a small Tangye boiler.

It is perhaps interesting here to note that this small boiler was originally fixed for battery retorting purposes, for which but a small quantity and slow generation of steam was required. Afterwards a small engine was attached to this boiler for the purpose of driving the lathes and a circular and band saw in the workshops above. In neither instance was the application made with the slightest reference to their employment eventually for electric lighting purposes. The dynamo is driven from the fly-wheel of the engine, necessitating at times a speed of 180 revolutions per minute. In order to raise steam sufficiently rapidly for this speed a steam blast has to be turned into the chimney. The arrangement is not an economical one, although as regards illumination it is in every way successful. It is understood, however, that the small boiler is about to be replaced by one having larger steam capacity, when no doubt the company will reap the full benefit of the electric light.



The entire installation and its arrangements have been carried out by the company's own officials. The diagram illustrating the arrangement shows in the varying thickness of the lines the different sized wire employed; the thickest, the main leads, being composed of 19 No. 16 copper wires, the sectional leads from these are composed of 7 No. 20 copper wires, and the leads to the individual lamps of No. 16 single copper wire. Fuses, composed of No. 35 copper wire, are inserted at various points in order to serve each shop, and where the number of lights, as in the carpenters' and mechanics' shop, is somewhat numerous, fuses are inserted for the protection of each group.

On the upper floor, C C, is the carpenters' shop with 13 lamps; P, the polishing shop, with 2; P^1, a passage, with 1; and M M, the mechanics' shop, containing 19 lamps.

The ground floor includes the insulator shop, I S, the battery room, B, the dynamo-electric machine, D; general stores, G S; outside platform, O P; office, O; and instrument room, I^1. These places account for 5, 10, 1, 3, 4, 6, and 2 lamps respectively.

Electric Lighting by Water-Power.—This is the title of a pamphlet by T. B. Grierson, C.E.I., and it is worthy of attention. Published by E. and F. N. Spon, Charing Cross.

SCREW GAUGES FOR ELECTRICAL WORK.

WE have received from the secretary of the Society of Arts, the report of the Committee, consisting of Sir Joseph Whitworth, Dr. Siemens, Sir F. J. Bramwell, Mr. A. Stroh, Mr. Beck, Mr. W. H. Preece, Mr. E. Crompton, Mr. E. Rigg, Mr. A. Le Neve Foster, Mr. Latimer Clark, Mr. Buckney, and Mr. H. Trueman Wood (Secretary), appointed for the purpose of determining a gauge for the manufacture of the various small screws used in telegraphic and electrical apparatus, in clockwork, and for other analagous purposes.

1. This Committee was formed by the General Committee of the British Association assembled at York in August and September, 1881, for the purpose of determining a gauge for the manufacture of the various small screws used in telegraphic and electrical apparatus, in clockwork, and for other analogous purposes.

2. At that meeting a paper was read by Mr. Preece, pointing out the desirability of establishing such a gauge. Although the Whitworth gauge is almost invariably adopted for the bolts and screws used in mill-work and engineering in England, no general system has been hitherto applied to the smaller screws used either in clockwork, philosophical instrument work, or in the numerous practical applications of electricity that are now rapidly becoming so important. In fact, at the present time gauges and screw plates almost equal in number the makers engaged in the trade. One instance was brought to the attention of the Committee by a manufacturer who had to execute an order for railway signal apparatus in accordance with three sample instruments, containing among them twenty-one screws of different threads, not one of which happened to be in use in his shop. There is now no recognised form of thread, no specified number of threads per inch—in fact, no generally accepted gauge based on practice and experience. Great inconvenience is felt in providing for repairs, which are in consequence more costly and less efficient.

The employment of some coherent and uniform system is manifestly required. It not only would render repairs easier, speedier, and cheaper, but it would introduce interchangeability of parts, and further the extension of piece work; and it would reduce the equipment of worshops with special and costly tools.

3. The subject of uniformity in screws has been very warmly taken up by the Société des Arts de Genève, which appointed a Committee in December, 1876, who, after assiduous labours, issued a report in 1878. The system proposed by them has been very fully described by Professor Thury in two pamphlets published in Geneva.[*] The Committee collected numerous screws of all sizes from many factories, measured them carefully, tabulated their several dimensions, and plotted the results by the ordinary method of linear co-ordinates. They determined the mathematical equations to curves that most closely corresponded with the ratios of diameter to pitch thus found to have been employed

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[*] "Systématique des Vis Horlogères," Geneva, 1878. "Notice sur le Système des Vis de la Filière Suisse," Geneva, 1880.

in practice, and adopted the one which most nearly represented the mean average proportions of the screws in use at various shops and in different countries.

The Swiss Committee took 1 millimetre pitch as the basis of their system. It was agreed that such a pitch was best adapted to a screw having a diameter of 6 millimetres. The form of thread adopted was triangular, the angle made by producing the two sides being approximately 47½° ; the depth being $\frac{3}{5}$ of the pitch, the top being rounded off by a radius $\frac{1}{6}$, and the bottom by a radius $\frac{1}{5}$ of the pitch.

The Committee has had an opportunity of examining screw plates and numerous packets of the corresponding screws manufactured on this system.

The following table gives the pitches and diameters in millimetres, and* "mils" to two significant figures, and the number of threads per inch of all the screws comprised in the small screw series, which happens to cover the exact ground to which the attention of the Committee has been specially directed, namely, diameters below the ¼-inch.

TABLE OF SWISS SCREWS.

No.	Pitch.		Diameter.		Threads per inch.
	Mm.	Mil.	Mm.	Mil.	
25	0·072	2·8	0·25	10	357
24	0·080	3·1	0·29	11	323
23	0·089	3·5	0·33	13	286
22	0·098	3·9	0·37	15	256
21	0·11	4·3	0·42	17	233
20	0·12	4·8	0·48	19	208
19	0·14	5·3	0·54	21	189
18	0·15	5·9	0·62	24	170
17	0·17	6·6	0·70	28	152
16	0·19	7·3	0·79	31	137
15	0·21	8·1	0·90	35	124
14	0·23	9·0	1·00	40	111
13	0·25	10·0	1·2	46	100
12	0·28	11·	1·3	52	91
11	0·31	12·	1·5	59	83
10	0·35	14·	1·7	67	71·4
9	0·39	15·	1·9	76	66·7
8	0·43	17·	2·2	86	58·8
7	0·48	19·	2·5	97	52·6
6	0·53	21·	2·8	111	47·6
5	0·59	23·	3·2	126	43·5
4	0·66	26·	3·6	142	38·5
3	0·73	29·	4·1	162	34·5
2	0·81	32·	4·7	183	31·2
1	0·90	35·	5·4	208	28·6
0	1·00	39·	6·0	236	25·6

It is to be observed that the numbers by which the screws are designated, given in the first column, are not arbitrary. Each pitch of the series is $\frac{9}{10}$ths of that which succeeds it in the table.

Thus the several pitches are :—

$$1 \text{ mm.} ; \frac{9}{10} \text{ mm.} ; \frac{9}{10}\Big)^2 \text{ mm.} ; \frac{9}{10}\Big)^3 \text{ mm.} ; \ldots \frac{9}{10}\Big)^n \text{ mm.}$$

This series may be expressed in the form :—

$$0{\cdot}9^0 ; 0{\cdot}9^1 ; 0{\cdot}9^2 ; 0{\cdot}9^3 ; \ldots . 0{\cdot}9^n ; \ldots \quad (1)$$

whence it is at once evident that the designating number of a screw is the index of the power to which 0·9 must be raised in order to ascertain its exact pitch in millimetres.

The method by which the relation between pitch and diameter is arrived at will be gathered from the following explanation :—

Let D represent the diameter and P the pitch. Then, generally,

$$D = f(P).$$

Evidently there can be no constant term, for when $D = 0$, P must also $= 0$. Moreover, D, practically cannot be a simple multiple of P, for experience has shown that small screws must have a less number of threads per diameter than large screws.

Hence the formula will be of the form

$$D = m\,P^k \quad . \quad . \quad . \quad (2)$$

where m and k are constants to be determined.

Since 1^k is 1 whatever be the value of k, it follows that the co-efficient, m, represents the value of D when P is 1. The Swiss Committee agreed that the unit pitch (1 millimetre) should be adopted for the screw having a diameter of 6 millimetres : in other words, they make $m = 6$.

The value of k must be ascertained by trial.

$k = 1$ would give a constant ratio, which we know is inadmissible.

$k = 2$ will be found on trial to give a far too rapid decrease in the ratio of diameter to pitch.

The several simple fractions between these limiting values were tried in succession, and the results obtained when using $\frac{6}{5}$ were found to give results that best accord with practice and experience.

Substituting the values thus arrived at in (2), the formula becomes

$$D = 6P^{\frac{6}{5}} \quad . \quad . \quad . \quad (3)$$

The Swiss system is thus very complete, but there are reasons which prevent this Committee from recommending its adoption in its entirety.

4. No one has done more to establish gauges of all kinds in England than Sir Joseph Whitworth. His classical paper on "An uniform system of screw threads" was communicated as far back as 1841 to the Institution of Civil Engineers. He had made an extensive collection of screw bolts from the principal workshops throughout England, and the average thread was carefully measured for different diameters. The ¼, ½, 1, and 1½ inches were selected and taken as the fixed points of a scale by which the intermediate sizes were regulated. The result is an admirable thread for the large iron bolts and screws used in fitting up steam-engines and other machinery. The angle made by the sides of this thread is 55°. One-sixth of the depth of the thread is rounded off from the top, and one-sixth from the bottom. The actual depth is rather more than three-fifths, and less than two-thirds of the pitch.

The slow adoption of such an admirable system was perhaps due, in great measure, to the fact that it was put forward by an individual and not by an association. A single individual, however exalted his reputation, cannot secure that immediate and universal attention which is obtained by such an organisation as the British Association. The system of units of electrical measurements sanctioned by the Association obtained instant recognition, and has now, thanks to the Congress of Electricians held in Paris in October, 1881, become universally accepted. It is hoped that the same result will follow the recommendations of this Committee.

5. The question of the introduction of the metrical system occupied the serious consideration of the Committee, but, considering the fact that it is not generally adopted in engineering or manufacture in England, and that it is as yet little understood by our workmen, it was thought better to suggest no change in this direction. The Committee is not insensible to the simplicity of the metrical system, and to its possible universality, nor to the fact of its gradual introduction in scientific circles, but while the manufacturing interests are still wedded to the British inch and its multiples and sub-multiples, and while the British legal standard of length is still the yard, the Committee has felt it impossible to suggest a change which has little chance of adoption, and which might jeopardise the introduction of that with which they are more concerned—viz., a uniform screw-thread.

Hence it was determined that the unit of length taken should be the "mil," and that the decimal system should be adopted for expressing dimensions.

6. The use of a screw is to draw together and to unite certain parts of apparatus in firm and intimate contact. To attain these ends a screw must facilitate the application of mechanical power to draw the parts together, and it must possess strength to hold them so ; it must not interfere with the easy separation of these united parts when necessary ; it must possess durability—that is, it must be capable of repeated use without undue friction and without wear, otherwise it will speedily become loose and dangerous when frequently removed and restored. There has to be considered the pitch of the screw, its relation to the diameter of the bolt on which it is cut, the depth of the cut, and the form of the thread. The pitch primarily determines the power of the screw, for it determines, for each diameter, the angle of the inclined plane ; the depth determines the section of core

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* The "mil" is the thousandth part of the British inch.

left to resist shear or rupture; while the form of the thread determines the durability and efficiency, and determines also the surface of thread to bear endway strain.

7. The Committee have devoted very considerable attention to the pitch, form, and depth of screws, and they have compared together a large number of different kinds, some of which are in actual use, while others have only been suggested. They have, moreover, decided on recommending the adoption of the Whitworth form of thread, not only because it is so well known, but because experience has proved it excellent and unsurpassed when employed for engineers' bolts. The Committee, however, are not unanimous on all questions involved by this proposal, and as there are several points that require to be thoroughly sifted and tested, they ask to be reconstituted, and to be allowed a small grant to put their proposal to the test of practice, and to have a few gauges constructed for distribution or examination.

ON EXPERIMENTS IN ELECTRIC LIGHTING IN THE STREETS OF BERLIN.

By VON HEFNER-ALTENECK.

In the history of the development of the electric light prominent points are marked out by successful street illuminations. For if we can venture to expose the light-apparatus not merely to wind and weather but to what is often worse, to the criticism of the public in the widest sense of the word, we have here a proof that the system in question has reached a high degree of perfection and of certainty in its action. Thus in the first half of the past decennium the most important discoveries were made in the matter of the electric light and very notable advances were effected, but it was still confined to factories, warehouses, &c., where its defects were overlooked for the sake of the direct advantage which it afforded. A general electric lighting of the streets was not thought of, and even after the introduction of the Jablochkoff candle the view generally taken was that with electric regulators, or as they are now commonly called, with electric arc lamps street lighting was impracticable. I can well remember with what utter incredulity it was received when I, by opportunity of negotiations with leading parties interested in the light question, did not at once reject the possibility of using regulators in ordinary street lamps. I did this with reference to the so-called pendulum-lamp, or lamp without propelling movement, which was then taking its rise among us, and which, in its mechanism, became the predecessor of the differential lamp.

As the true starting-point for street lighting we must recognise the arrangement made in Paris with the Jablochkoff candle in the winter of 1877-78 in the Place de l'Opéra and in the following summer in the Avenue de l'Opéra. As striking in their effect and as epoch-making as these illuminations were, it was still plain that the lights burnt too unsteadily and with too much change of colour to earn permanent approval; they were also uncertain in action. The Jablochkoff candle, with its parallel carbon rods had quite superseded mechanical lamps; but the power of re-ignition was lost if the light was once extinguished, which happened with relative ease.

The next step in the history of public street lighting must be traced in Berlin. It is marked by the illumination of the Kaisergallerie during the Industrial Exhibition in Berlin, 1879, executed by the firm of Siemens and Halske —the first arrangement with divided arc lights, several being introduced into one circuit, and with differential regulation. The success of this plan is so well known and so fully recognised that I do not need to discuss it at length. I will merely point out that it depends not alone on the subdivision of the electric light effected by the differential regulation, but on the improvements of the mechanism combined in the differential lamp, which made it a simple and a safely-acting apparatus.

Among these improvements must be reckoned, besides the iron rod with the two coils attracting it differentially into themselves, the exclusive movement of the upper carbon-rod, so that the transfer of contact to the rack-work takes place with strong pressure and friction, without interfering with the delicate regulatory movements of the carbon-rod; the correct checking these movements by an air-cushion; the production—decisive for practical use—of an exclusion contact which automatically throws a spent lamp out of the circuit, and, at the same time, preserves all other lamps of the same circuit from extinction; the absence of a regulation-screw, which, in lamps of earlier patterns, was often tampered with, or, at least, was readily displaced. In the Kaisergallerie burnt for the first time the so-called "wick-carbons," furnished by Siemens Bros., of Charlottenburg. These are distinguished by their steady burning, and are at present obtained from that firm by almost all who furnish subdivided lights. The new pattern of the differential lamp contributed no little to its adoption, and has become almost universal for electric lamps. The earlier regulators had all, as far as I remember, the box with the mechanism placed *below*, and thus their introduction in ordinary street lamps was out of the question. By placing the mechanism *above* the carbon rods, and by enclosure in a cylindrical case, the differential lamp was not only made to give its light without throwing a shadow, but its adaptability to various lamp-frames and a tasteful appearance were secured.

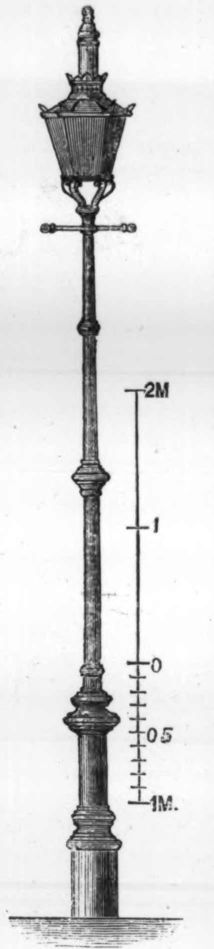
The success of the illumination of the Kaisergallerie and the permanent plant produced soon afterwards on the same system, emboldened other manufacturers to proceed in the same or in a similar direction. Thus in 1881 the Paris Exhibition was chiefly illuminated with arc lights which had mostly the same form and in part depended upon the same principles as the differential lamp. These, along with the Brush lamps introduced from America, and the incandescence lamps (which there made their first appearance on the large scale), contributed no little to the success of the Exhibition. At present many thousand differential lamps are in action, and as an instance of the extended adoption of the electric light I will merely mention that wick-carbons annually consumed, as furnished by the firm of Siemens and Halske, alone make up a total length of hundreds of kilometres. The adoption of the arc-light is still increasing. I believe that the recently-introduced incandescence lights will not reduce, but will rather tend to increase, their use. I hold still the same opinion which I expressed two years ago in a discourse on the subdivision of the electric light—a time when the incandescent lamps were still in poor repute—and I shall again return to the subject.

From the above-described occurrences the question of the electric illumination of public streets, &c., in Berlin, by means of the differential lamp was not likely to be passed over. At the end of 1880 a project was formed for lighting up the squares of the Arsenal and the Opera House by means of such lamps was handed in. The accommodation of the engine-house in this district had, contrary to the very general opinion, no especial difficulties, for as soon as it was found that the needful water-power could not be obtained near at hand, three localities were proposed for selection in the project—behind the University; in an arch of the City Railway; and an old engine-house near the Museum.

On August 10th, 1880, an experiment in electric lighting was made in the Pariser Platz, which though it lasted only for a few hours was of much interest. In the lawns on each side of the fountain there were erected four masts, two on each side, 11 metres in height, and bearing differential lamps each of 1,200 normal candle-power. Although the electric lights were thus in a less favourable position as regards the middle of the Platz than the brilliant gas-lamps they lighted up even the middle of the space better than the latter, so that the seconds-hand of a watch could be distinctly seen. The surrounding palaces were lighted up incomparably better than by gas.

The plan was not carried out in view of the splendid gas illumination, which, to the joy of the Berlinese, lights up the Pariser Platz. It ranks among the good properties of the electric arc light that wherever it is seen, even from afar, it gives rise to energetic efforts in gas-lighting.

Before passing to the most brilliant of the Berlin experiments—that of the Leipziger Strasse—I must mention the illumination carried on from May 15th to September 15th this year, by Siemens and Halske with incandescence lights, in that part of the Koch Strasse which lies between the Friedrichs—and the Markgrafen—Strasse. The current was generated by a dynamo-electric machine (D 18) set up in the factory of the firm, connected directly (*i.e.*, without driving-bands) with a steam-engine on Dalgomki's system.



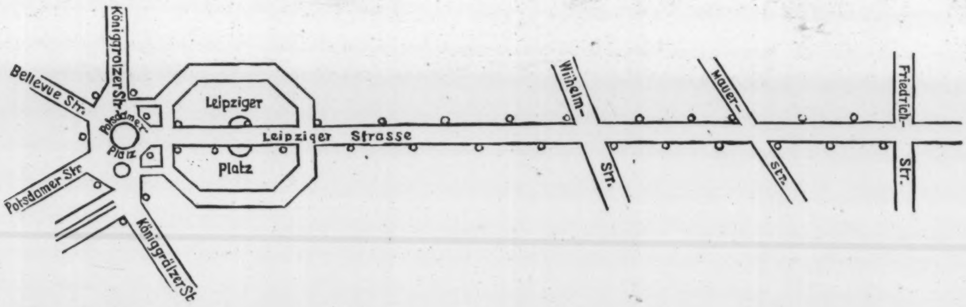
This engine, the manufacture of which in Germany has been undertaken by Siemens and Halske, is distinguished by extraordinary smallness and rapidity of revolution. The conductors were carried, with the consent of the authorities and the householders, along the fronts of the houses and then from lamp to lamp. For the return-conductors the earth and the system of gas-piping were employed, but as it appeared that some of the lamp-posts were not in good connection with the latter, they were also connected together above ground, hence the second wire between the lamps—a puzzle to many electricians. The 20 lamps were introduced into the circuit parallel to each other, and in order to obtain a sufficient height and to secure the possibility of burning gas at the same time (which always took place after midnight) they were fixed above the gas lamps. The lighting, during its entire duration of four months, was maintained at the sole cost of Siemens and Halske, and had consequently the character of an experiment which the firm made in order to gather experience concerning their incandescence lamps. It has also a historical importance as being the first attempt at street lighting on the continent with incandescence lamps. The entire character and value of these lamps consists, as is known, not in the cheap production of great masses of light, but that, along with other ad-advantages, they are capable of taking the place of gas as far as divisibility is concerned. This was to be shown by the experiment in the Koch Strasse, and the lamps were, therefore, selected only so much brighter than gas-flames as to compensate for their greater height. Each of them was about = 25 normal candles, whilst a Berlin street gas-lamp = 17. It must be said that the public did not particularly appreciate the undertaking. Passers-by were often heard to say: "That the electric light? It burns like gas!"

The experiment will be repeated for a short time, with apparently much improved incandescence lamps, manufactured by Siemens Bros., in Charlottenburg. The lamps, of course, with a proportionate increase of current and motor-power, are to give each the light of 130 normal candles, so that the effect will about equal that of Fritz Siemens' "regenerative gas-burners" in the Leipziger Strasse.

After the above-mentioned project for lighting the Arsenal and Opera Square had been declined by the authorities, on the very plausible ground that so select a district, inhabited by personages of the highest rank, was unsuitable for an experiment, attention was turned to the Potsdamer Platz, one of the busiest localities in Berlin, and in which the most accidents happen, and also to a part of the Koniggrätzer Strasse. In place of the latter street, which is not a great thoroughfare, Siemens and Halske proposed the Leipziger Strasse, as far as Friedrichs Strasse; and then, as the projected quantity of light would be unnecessarily great for this short distance, and the cost would thus appear excessive, they proposed to extend the lighting up to the Friedrichs Strasse, still retaining the original number of lamps, as it has been carried into effect. I mention this circumstance because it determines the distance of the lamps from each other, which is sometimes considered as rather great, though an increased light is not demanded.

If it has been viewed with regret on many sides that by reason of the conduct of the authorities, Berlin has been slower in obtaining electric street lighting than other cities, slower especially than might be expected from the energy displayed there in electro-technics, it must be admitted that the time thus expended has been an advantage to the arrangements as finally carried out, since it has permitted the adoption of many little improvements in the apparatus. Though Paris has the merit of having taken the lead in this direction, yet it is indisputable that if we compare the actually existing arrangements in both cities, Berlin is the better lighted of the two. The cleverly devised gas arrangements put up for comparison must contribute to a rational promotion of the whole system of street lighting. The old proverb "hasten slowly" is of value, even in electrical improvements.

The portion of the Leipziger Strasse lighted with 25 electric lamps is 820 metres long and 22 broad. The lamps in each of the two ranks are at the distance of 75 metres from each other and 5½ metres high to the middle of the



lamp. 11 lamps light up the Potsdamer Platz. The engine-house is a specially-constructed building, with a massive front wall at No. 95, Wilhelms Strasse, where the latter is broken through for the prolongation of the Zimmer Strasse. It is 250 metres from the nearest lamp. In it are four 12-horse Otto Langen gas-engines which, quite unconnected with each other, drive each a dynamo-electric machine D_0. Three of these machines supply each 12 differential lamps placed in one circuit, the fourth engine and dynamo-machine forming a reserve. Each system of machines can be connected with each circuit or placed in reserve, as the latter can be quickly exchanged in case of any irregularity of action. The electric conductors are carried underground and up the interior of the lamp-posts in three circuits quite distinct from each other. In view of the high tension of the currents employed no common or non-insulated return-conductor or earth-conductor has been taken into consideration, so that, *e.g.*, in the Wilhelm Strasse there lie six cables alongside of each other between the engine-house and the first lamp. The cables were laid and the lamps set up within the lapse of 12 working days and without any hindrance to traffic. Streets paved with asphalt had to be crossed in five places and this was effected by boring and inserting iron pipes.

(*To be Continued.*)

FORCE: ITS ORIGIN AND THE PHILOSOPHY OF ITS DEVELOPMENT.

ALL the forces of the Universe, whether they bind celestial spheres, or work among individual atoms of matter, are products of a universal force, the totality of which we may rationally suppose has been invariable since its genesis. The great problem now opening to scientific and philosophic minds is the demonstration of the nature of this universal force.

It is admitted that up to the present half century the data for the working out of this problem have not existed. The varied physical phenomena have of necessity hitherto received only crude and irrational explanations, that have passed current for want of better. The greatest minds lacking certain necessary factors of the problem, have retired baffled from the attempt at its solution. At the same time wise and thoughtful men have had premonitions of the actual unity of all the physical forces and eagerly anticipated its discovery. But to-day it is to be recognised that the times have ripened fast. The abundant inventions and discoveries of our own age, rightly interpreted, already furnish the data heretofore wanting, and now the long waiting problem is capable of rational solution. But few missing links remain for the imagination to supply. It is indeed not too much to affirm that the new philosophy has already been born which shall crown our century with glory.

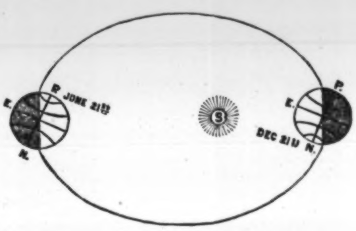
The highest achievement in discovery during the present, or any other age, is found in the verified law of conservation of force. Scientists bow to its authority universally. It already stands as the touchstone, or test, of all scientific theories relating to the so-called "physical forces," so that the theory that is incompatible with that law may be safely rejected without further examination.

The pre-requisite for the construction of a new physical philosophy is the demonstration of a universal force acting in consistency with the law "conservation." This philosophy must, therefore, make of force and its phenomena an *exact science*. Where then is such a force? In searching the universe for a power commensurate with such stupendous demands, the requirements are met only in a single available source to which the aggregate or sum of all force may be referred. This sole source is *the motions of the celestial spheres.*

Some approximate idea of the amount of force induced by these motions and its entire sufficiency for all the demands, may be gathered from the simple statement of this problem: given; the mass of the earth, its bulk and its velocity (rotary and progressive), to find the power. This statement relates to a single celestial sphere, yet it represents a power sufficient, we may believe, for all terrestial needs. The same process applied to the innumerable host of celestial spheres satisfactorily expresses the aggregate force of the universe.

Let us briefly consider the office of the celestiai motions. They call into action a constituent element of each celestial body. We call it the magnetic element. Our earth, for example, is known to be a vast magnet, having a magnetic axis, approximating to its geographical axis, in position, and terminating in a positive, or northern pole, and in a negative, or southern pole. But this inherent magnetic constituent is quiescent, is purely potential, or static, and without the ability to act or to move, except through the operation of the celestial motions. Through these motions static magnetism becomes converted into vital active currents.

That magnetism conjoined with motion may be made the source of electricity is well understood. So by their unceasing rotation the magnetic sun and earth furnish the needed motions, and also the incessant changes of polarity, which are requisite to the completion of the *celestial battery*. Thus through the medium of revolving celestial armatures acting upon celestial magnets, statics are converted into dynamics on a scale commensurate with the demands of the Universe.



The fact that electrical currents pass between the sun and earth is fully accepted of science. The bright sun spot of 1859, simultaneously seen by different observers, produced instantaneous and violent electrical disturbance over portions of two continents.

This is proof of electrical communication and stands as a fact independent of all methods and theories of explanation. the inter-relation of sun-spot and auroral phenomena is now regarded as fully established by positive demonstration. *In this magnetic inter-action, or inter-relation, is found the key to the whole subject of universal force and to the methods of its operation.* If inter-action between the spheres takes place through the medium of electrical currents, then, most assuredly, those electrical currents must have their origin in some electrical source and be subject to electrical laws. Our present knowledge of the laws of electrical action is sufficiently abundant and exact to afford a clear insight into the philosophy of the operation of the great *Sun-Battery*. Electrical action on the grander scale of the celestial spheres may, therefore, be studied intelligently through the demonstrations of the lesser scale of our terrestial magneto and dynamo-electric machines.

Polarity is a fundamental law of electricity. The currents, however generated, whether magnetically or electrically, cannot act or move, except through the agency of positive or negative conditions. A *circuit* is therefore indispensable to its operations. If currents come from the sun to the earth, retro-acting currents must inevitably return to the sun. This is rendered indispensable equally by the law of conservation of force and by the laws of electricity. If this force thus governs the solar system so also does it govern the Universe.

The infinite distance which intervenes between the celestial spheres offers no obstacle to the inter-action of the electrical force. All inter-stellar space being essentially a vacuum, distance is annihilated, and all the sphere are brought relatively into close proximity—Mercury, 37 millions of miles from the sun and Neptune 2,800 millions of miles, stand alike in their relations with the sun. It is now well known that a number of currents may pass in each direction at the same instant, over one and the same telegraph wire and in like manner, great solar currents may pass to and fro, without interference. The force which controls the Universe is thus found to be purely electrical. Upon the electrical theory, and upon that *alone*, may all physical phenomena be explained. We use the term electricity in its generic sense—electricity and magnetism being essentially the same.

What electricity *is* no man knows—what its laws no man yet fully comprehends. Additional knowledge of its varied and marvellous powers is being disclosed to us daily. Its future is big with promise. Upon such of its teachings as science recognises as *exact* we found our *New Philosophy*.

The so-called great physical forces are but merely affections or manifestations of the *One Great Primordial Force*. These varied phenomena must, therefore, find their fullest and clearest explanations through the interpretations given by the electrical theory.

GRAVITY AS ONE OF THESE AFFECTIONS.

This, the most impressive of physical phenomena, finds its clearest explanation in simple electrical action. Bodies become centres of attraction through the operation of the electrical current. A body of soft iron is thus made magnetic, and remains so, during the continuance of the current. Through so simple an experiment we are taught that *the current which forms the* GRAND CIRCUIT *incessantly in play between the sun and earth* IMBUES *those spheres with powers of* ATTRACTION *or* GRAVITY ; *hence the* GENESIS *of that greatest of forces.* It may, therefore, be treated as an electrical phenomenon. Gravity is thus shown to be correlated with all the other great forces. This simple explanation brings this hitherto mysterious force down to the ordinary comprehension.

The electrical theory of gravity is itself a rational, clear and satisfactory philosophy, and easily takes the place of all former theories. It is capable of accounting for all the phenomena most satisfactorily. It accounts for the elliptical orbits of the members of the solar system. In order that the earth's orbit, for example, should be elliptical, the mutual attraction existing between the sun and the earth must necessarily increase and diminish with mathematical exactness and regularity. To such regularly varying attraction, and to no other cause, can the ellipticity be due. The mutual attraction is greatest about the 21st of December, when those bodies are nearest each other ; and least about the 21st of June, when they are relatively the most distant. Whether the attraction between the sun and earth shall be greater, or shall be less, depends altogether upon their relative position. Thus, when the earth's south pole presents nearest the sun, the attraction between the two bodies is greatest ; and when the north pole so presents, attraction is least. Why should this variation in position produce such a variation in attraction ? In the light of the electrical theory the following explanation is advanced.

On the 21st of December the positive sun (S) and the negative south-pole of the earth's magnetic axis (N) are in closest relations to each other, and the north-pole (P) is out of the field, therefore the opposing conditions, viz., the *positive* sun and the *negative* portion of the earth, represented by the south-pole, acting in concert, produce attraction between the two bodies, according to the electrical law that unlikes attract each other. On the 21st of June precisely opposite conditions exist. The *positive* sun and the *positive* north-pole are in closest relations to each other, and the south-pole is out of the field, attraction between the two bodies is, consequently, at that date lessened, and this in accordance with the electrical law that likes repel each other ; therefore at that date they are found at their greatest distance apart, viz., several millions of miles more distant than on the 21st of December. On the 20th of March, and on the 20th of September, the sun is equidistant from the earth's two polar extremities and the electrical conditions are balanced, and the earth at those periods is equally distant from the sun. Thus the *polarity* of the spheres determines the ellipticity of their orbits.

Such ellipticity cannot be satisfactorily explained by the old laws of gravitation, viz., of direct action and inverse squares. If the earth in its orbit were acted upon simultaneously according to both of these laws, it would surely yield to the stronger. During the half of each year, from the autumnal to the vernal equinox, the sun holds the earth (so to speak) at short range, and from perihelion to aphelion the earth advances *diagonally against* the central attraction of the sun. These facts amount to a rational demonstration that each succeeding round, the earth would fail to reach the farthest limits of the preceding one. The tendency, therefore, would be to bring the orbit into a perfect circle speedily.

Gravity, therefore, as applied to the motions of the celestial spheres, is a legitimate action of the universal magnetic force, and acts entirely independently of the philosophy of the present dogmas, as set forth in text-books, cyclopædia articles, and in the popular conception. Present scientific authorities almost uniformly represent gravity as resident in particles and masses of matter, by virtue of which each particle, or mass, attracts every other. But the greatest of our philosophers have found an insuperable difficulty in a purely inherent force of attraction, and have believed in the existence of some *agent*, at the time unknown to them, that was the *cause* of the attraction called *gravitation.*

That prince of philosophers, Faraday, testifies to not only his own, but also Newton's dissatisfaction with that view. He says : "The usual idea of the force implies *direct* action at a distance ; and such a view appears to present little difficulty except to Newton and a few, including myself." Faraday declares that "the usual definition of gravity, as an attractive force between the particles of matter *varying* inversely as the square of the distance, whilst it stands as a full definition of the power, is inconsistent with the principles of conservation of force." "For my own part," he says, "many considerations urge my mind towards the idea of a *cause* of gravity which is not resident in the particles of matter merely, but constantly in them and in all space." In other words, he believed that gravity is produced by the action of some external agency which would account for its varying degrees of force at different distances. He reiterated that nothing could be more in contrast with the *assumed* variable condition of the gravitating force *supposed* to reside in the particles of matter than the known facts of gravity.

Newton himself, in direct contrast with what is considered as his theory, says that "gravity should be innate, inherent, and essential to matter, so that one body may act upon another at a distance, through a vacuum, without the medium of anything else, by and through which their action and force may be conveyed from one to another, is to me so great an absurdity that I believe that no man who has in philosophical matters a competent faculty of thinking can ever fall into it."

To a friend he wrote : "It is inconceivable that innate brute matter should without the mediation of something else which is not material operate on and effect other matter, without mutual contact, as it must do if gravitation, in the sense of Epicurus, be essential and inherent in it. And this is the reason why I desire you would not ascribe innate gravity to me."

Thirty years subsequently to the enunciation of his theories, and nine years before his death, he deemed it necessary to state that he did not by any means consider gravity as an essential property of bodies. "Gravity," he says, "must be caused by an *agent*, acting constantly according to certain laws ; but whether this agent be material or immaterial I have left to the consideration of my reader."

Is it not safely affirmed that the data lacking in the days of Newton and Faraday are now at hand ? Modern discoveries in electricity have revealed the "*agent*" which those great men believed in and sought after.

The great truth, amply sufficient to a complete interpretation, is this, that *bodies become centres of attraction through the operation of the electrical current.*

All the remaining affections of the *universal force* now classified as the "*great physical forces,*" can only be satisfactorily explained upon the electrical theory.

Several yet unrecognised affections of the great *one-Force*, that are legitimately entitled to a place in that category, are also clearly and satisfactorily accounted for upon that basis. Among these are sound, wind, cold, crystallisation, &c.

The *prime factors* in the problem of Universal Force are : (1.) The motions of the celestial spheres, due to a *primum mobile* wholly undemonstrable ; and (2), *the magnetism inherent in those spheres.* In these agencies, and in the performance of their legitimate functions, we find "the *Origin* of *Force* and the *Philosophy* of its *Development*."

[This article was originally written for the New York *Journal of the Telegraph*, by Henry Raymond Rogers, M.D., who kindly sent us an early copy, and block to illustrate the same.—EDS. ELEC. REV.]

ON ELECTRIC LIGHT LEADS.

By ROBERT SABINE.

THE want is continually felt of some ready way—and surer than the rule-of-thumb method usually resorted to—of answering the plain question: Given the necessary current, the maximum H. P. to be expended in the lead, and distances of the lamps from the dynamo, what thickness of copper will be required?

It has occurred to me that the best way in which this want could be supplied would be by the issue of a set of tables, having a range sufficiently extended to embrace all the various conditions which are commonly met with. Such a set of tables, if issued with the authority of the Telegraph Society within whose province the subject falls, would be a great boon to many who are engaged in electric lighting pursuits, and occasionally save a good deal of trouble, copper, or engine-power.

By way of illustrating a way in which this might be done, I have constructed the following two tables of the H. P. consumed in 1 kilometre length of cylindrical (97 per cent. conductivity) copper wire or rod of various diameters. Table I. for currents ranging from 5 to 90 ampères, and Table II. from 100 to 1,000 ampères; and I have added the approximate elevation of temperature, during the working, which would be found if the conductors were in the air.

I.—FOR CURRENTS FROM 5 TO 90 AMPERES.

Diameter of conductors in centimetres.	5a.		10a.		20a.		30a.		40a.		50a.		60a.		70a.		80a.		90a.	
	H. P. abs. per kilom.	Rise of temp	H. P. abs. per kilom.	Rise of temp.	H. P. abs. per kilom.	Rise of temp.	H. P. abs. per kilom.	Rise of temp.	H. P. abs. per kilom.	Rise of temp.	H. P. abs. per kilom.	Rise of temp.	H. P. abs. per kilom.	Rise of temp.	H. P. abs. per kilom.	Rise of temp.	H. P. abs. per kilom.	Rise of temp.	H. P. abs. per kilom.	Rise of temp.
		Deg. C.		Deg. C.		Deg. C.		Deg. C.		Deg. C.		Deg. C.		Deg. C.		Deg. C.		Deg. C.		Deg. C.
0·1	·72	21	2·9	82	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
·15	·32	6	1·1	24	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
·2	·18	3	·72	10	2·9	41	6·9	92	...	...	...	...	...	...	...	...	...	...	...	...
·25	·11	1	·46	5	1·8	21	4·4	47	...	...	...	...	...	...	...	...	...	...	...	...
·3	·08	·8	·32	3	1·2	12	3·1	27	5·1	49	...	...	...	...	...	...	...	...	...	...
·35	·06	·5	·23	2	·92	7	2·2	17	3·7	28	...	...	...	...	...	...	...	...	...	...
·4	·05	·3	·18	1	·72	5	1·7	11	2·9	21	4·5	32	...	...	...	...	...	...	...	...
·5	...	...	·11	·7	·45	3	1·1	5	1·8	11	2·9	16	4·1	24	5·6	32	7·3	42	9·3	·53
·6	...	...	·08	·4	·32	2	·77	3	1·3	6	2·0	10	2·9	14	3·9	·19	5·1	24	6·5	31
·7	...	...	·06	·2	·28	1	·56	2	·94	4	1·5	6	2·1	9	2·9	12	3·7	15	4·7	19
·8	...	...	·05	·2	·18	·6	·43	1	·72	3	1·1	4	1·6	6	2·2	8	2·9	10	3·6	13
·9	...	...	·04	·1	·14	·4	·34	1	·57	2	·89	3	1·3	4	1·7	6	2·3	7	2·9	9
1·0	...	...	...	...	·12	·3	·28	·7	·46	1	·72	2	1·0	3	1·4	4	1·8	5	2·3	7
1·1	...	...	...	...	·10	·2	·23	·6	·41	1	·59	2	·85	2	1·2	3	1·5	4	1·9	5
1·2	...	...	...	...	...	...	·19	·4	·32	·8	·50	1	·72	2	·98	2·	1·3	3	1·6	4
1·3	...	...	...	...	...	...	·16	·3	·27	·6	·42	1	·61	1	·83	2·	1·1	2	1·4	3
1·4	...	...	...	...	...	...	...	...	·23	·5	·37	·8	·53	1	·72	2·	·94	2	1·2	2
1·5	...	...	...	...	...	...	...	...	·20	·4	·32	·6	·46	·9	·62	1·	·81	2	1·0	2
1·6	...	...	...	...	...	...	...	...	...	...	·28	·5	·40	·8	·55	1·	·72	1	·91	2
1·7	...	...	...	...	...	...	...	...	...	...	·25	·4	·36	·6	·49	·8	·64	1	·81	1
1·8	...	...	...	...	...	...	...	...	...	...	...	...	·32	·5	·43	·7	·57	·9	·71	1
1·9	...	...	...	...	...	...	...	...	...	...	...	...	·29	·4	·39	·6	·51	·8	·64	1
2·0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	·35	·5	·46	·7	·58	1

II.—FOR CURRENTS FROM 100 TO 1,000 AMPERES.

Diameter of conductors in centimetres.	100a.		200a.		300a.		400a.		500a.		600a.		700a.		800a.		900a.		1000a.	
	H. P. abs. per kilom.	Rise of temp.	H. P. abs. per kilom.	Rise of temp.	H. P. abs. per kilom.	Rise of temp.	H. P. abs. per kilom.	Rise of temp.	H. P. abs. per kilom.	Rise of temp.	H. P. abs. per kilom.	Rise of temp.	H. P. abs. per kilom.	Rise of temp.	H. P. abs. per kilom.	Rise of temp.	H. P. abs. per kilom.	Rise of temp.	H. P. abs. per kilom.	Rise of temp.
		Deg. C.		Deg. C.		Deg. C.		Deg. C.		Deg. C.		Deg. C.		Deg. C.		Deg. C.		Deg. C.		Deg. C.
0·6	8·0	38	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
0·7	5·8	24	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
0·8	4·5	16	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
0·9	3·5	11	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1·0	2·9	8	11·5	33	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1·1	2·4	6	9·5	25	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1·2	2·0	5	8·0	19	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1·3	1·7	4	6·8	15	15	34	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1·4	1·5	3	5·9	12	13	27	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1·5	1·3	2	5·1	10	11	22	20	39	...	...	...	...	...	...	...	...	...	...	...	...
1·6	1·1	2	4·5	8	10	18	18	32	...	...	...	...	...	...	...	...	...	...	...	...
1·7	1·0	2	4·0	7	8·9	15	16	27	...	...	...	...	...	...	...	...	...	...	...	...
1·8	·9	1	3·5	6	8·0	13	14	23	22	35	...	...	...	...	...	...	...	...	...	...
1·9	·8	1	3·1	5	7·1	11	13	19	20	30	...	...	...	...	...	...	...	...	...	...
2·0	·7	1	2·9	4	6·4	9	11	16	18	25	26	37	...	...	...	...	...	...	...	...
2·2	·6	1	2·4	3	5·3	7	9·5	12	15	19	21	28	...	...	...	...	...	...	...	...
2·4	·5	1	2·0	2	4·5	5	8·0	10	13	15	18	21	...	...	...	...	...	...	...	...
2·6	...	...	1·7	2	3·8	4	6·8	8	11	12	15	17	21	24	...	...	...	...	...	...
2·8	...	...	1·4	2	3·3	3	5·8	6	9·1	9	13	13	18	18	23	24	...	...	...	...
3·0	...	...	1·3	1	2·9	3	5·1	5	8·0	8	11	11	16	15	20	20	26	25	32	30
3·2	...	...	...	...	2·5	2	4·5	4	7·0	6	10	9	13	12	18	16	23	20	28	25
3·4	...	...	...	...	2·2	2	3·9	3	6·2	5	8·7	8	12	10	16	13	20	17	25	21
3·6	...	...	...	...	2·0	2	3·5	3	5·4	4	7·9	6	11	9	14	11	18	14	22	18
3·8	...	...	...	...	...	...	3·2	2	5·0	4	7·1	5	10	7	12	9	16	12	20	15
4·0	...	...	...	...	...	...	...	...	4·5	3	6·4	5	8·8	6	11	8	15	10	18	12
4·5	...	...	...	...	...	...	...	...	3·5	2	5·1	3	6·9	4	9·1	6	11	7	14	9
5·0	...	...	...	...	...	...	...	...	...	...	4·1	2	5·6	3	7·3	4	9·3	5	11	6
5·5	...	...	...	...	...	...	...	...	...	...	...	...	4·7	2	6·1	3	7·7	4	9·5	5
6·0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5·1	2	6·4	3	7·9	4

The following examples will serve to illustrate the way in which these tables may be used :—

EXAMPLE I.—An installation of 10 Jablochkoff lamps, in series, is required, the furthest lamp being at a distance of five kilometres from the dynamo. The total available H. P. is 5·5 indicated, and of this not more than 0·5 H. P. must be wasted in the leads. Required : the size of wire which will do this when the average current is five ampères.

ANSWER.—Length of leads = 2 × 5 = 10 kilometres. The available H. P. per kilometre in the leads is, therefore,

$$\frac{0{\cdot}5}{10} = 0{\cdot}05 \text{ H. P.}$$

Referring to table I., under column 5 ampères, the value 0·05 H. P. is found to correspond with a diameter of 0·4 cm., which is the diameter required.

EXAMPLE II.—I want to erect 1,500 Edison filament lamps of the "A" pattern, a kilometre distant from the dynamo, the whole lead being 2 kilometres long, of suspended copper wire. Each Edison may take a current of 0·67 ampères, and the whole 1,500, requiring therefore 1,005 ampères. The temperature of the wire must, for some reason, not exceed 50° C. (= 122° F.) in summer, when the temperature of the air is 25° C. Required : the diameter of copper which will do this and the H. P. which the leads will account for?

ANSWER.—The temperature difference, 50° — 25° = 25° C., will be found in the column under 1,000 ampères, in the horizontal line corresponding with 3·2 cm. diameter, and with an expenditure of 2 8 H. P. per kilometre, or 28 × 2 = 56 H. P. in the lead.

EXAMPLE III.—I want 40 Brush lamps, each lamp requiring a potential difference of 50 volts and a current of 10 ampères, to be connected up in series at 1·5 kilometres from the dynamo. I cannot afford to expend in the leads more than one-tenth of what is accounted for in the lamps. Required: the diameter of copper?

ANSWER.—Each lamp will account for

$$\frac{10 \times 50}{746} = 0{\cdot}67 \text{ H. P.,}$$

and the 20 lamps, therefore, 20 × 0·67 = 13·4 H. P.

Only $\frac{13{\cdot}4}{10} = 1{\cdot}34$ H. P. is to be expended in the leads. The length of the leads is 2 × 1·5 = 3 kilometres, and the H. P. available per kilometre is

$$\frac{1{\cdot}34}{3} = 0{\cdot}45 \text{ H. P.}$$

In table I., under 10 ampères, the value 0·46 H. P. will be found to correspond with a diameter of 0·25 cm.

These examples are only intended to illustrate the use of such tables as those I have suggested, and not as illustrations of the manner in which either of the existing systems I have mentioned is perhaps really worked. The tables themselves are also only intended as tentative, and do not pretend to be either strictly exact or so comprehensive as to be generally applicable. My present object is simply to show that some such tables are very desirable.

Five-and-twenty years ago the dimensions of telegraph cable cores were determined much in the same rule-of-thumb way in which electric light leads are frequently determined to-day. Telegraphy has, however, advanced beyond this stage, and the dimensions of conductor and insulator are now determined with the utmost exactitude for the work which any given cable is intended to do. The sooner such exactitude is generally introduced into electric light work the better. Short leads, of course, whether for telegraph or light purposes, demand no particular consideration, but relatively long lines, for either purpose, become matters of importance ; and while the successful distribution of the electric light depends to so great an extent upon the efficiency of the leads, too much care cannot be taken to have them not only of the best quality but in the best proportions.

The efficiency of insulated leads for light purposes is not to be judged strictly by the same rules which apply to covered core for telegraph purposes, some conditions required to be met being different. The only conditions, in fact, in common are a sufficient weight of copper to carry the current, and a sufficient covering of insulator to prevent its escape. In designing a long telegraph line, we have to provide against the development of induction ; in light leads we have to provide against the development of heat. The development of induction is practically non-existent in light leads, while that of heat is practically absent in telegraph lines.

While at work, the tendency of all light leads is to get warmer. How much warmer depends upon a balance between two things, viz., the heat generated by the current, and the facility with which this heat can escape into and through the insulating covering. This heat is an item of waste which cannot be wholly avoided, although it may be reduced to a minimum. If the insulating covering were as efficient an insulator for heat as for electricity, no covered wire could escape becoming, in time, when in use, incandescent. But happily those materials which are chosen in practice for electrical insulators are, as a rule, not good heat insulators.

Air and glass—two of the best electrical insulators—are very indifferent heat insulators. Vulcanite—an excellent electrical insulator—is, when thin, highly diathermanous. India-rubber—the material most generally used for insulating electric light leads—stands only second in diathermancy to vulcanite—a property, by virtue of which the heat generated by the current, instead of being bottled up and accumulating to the detriment of the system, is easily passed through the insulating covering and liberated. The elevation of the temperature of any lead is proportional to the obstruction which the insulator offers to the escape of the heat generated in it.

In specifying an insulated wire for any special electric lighting system, the aim of the engineer is to get the required current through it with as little waste of electricity and of power, and as little retention of heat, as possible. This is done by the employment of a sufficient section of copper enveloped in an insulating covering of suitable material, thick enough to ensure a durable and uniform resistance, very great in comparison with that of the copper, but, at the same time, thin enough to prevent any unnecessary obstruction to the escape of the heat which the current generates. Given on a lead an insulation covering which is sufficient both electrically and mechanically, it is qualitatively detrimental to increase the thickness of the covering, because any increase tends to bottle up the heat which we want to get rid of, to increase the resistance and the consumption of engine-power. Therefore, in choosing between two electric light leads, both assumed to be sufficiently insulated, the one with the thinner covering may be found to be the cheaper of the two in working, while it will certainly be the cheaper of the two in first cost.

In this regard the rule which may be followed in the design of an electric light lead is at variance with that which is followed in dealing with telegraph cables. Much the same may be said with regard to the conductor. In telegraph cables the employment of a strand of seven wires instead of a solid wire is attended with considerable mechanical advantages, while from an electrical point of view, as far as conduction goes—the section remaining the same—the form is immaterial. In an electric light lead, apart from mechanical considerations, the strand form is not so good as the solid section. The heat generated by a current should be radiated as fast as it can be from the surface, and as heat is developed at all points of the section at about an equal rate there follows a continuous flow of heat from the centre towards the circumference. If we wish to give our conductor the maximum facility for getting rid of this heat it is essential that the flow in question should be obstructed as little as possible. A solid section is consequently preferable to one which is discontinuous. In practice this is a small matter, but it illustrates what I said before, that the same rules are not strictly applicable to telegraph and electric light conductors.

One of the principal conditions which is very properly insisted upon in specifying electric light leads is high conductivity of the copper. Matthiessen in 1860 found commercial copper to vary as much as six to one in conductivity; that is to say, the same sized copper wire in a lead might waste one H. P. or it might waste six H. P., according to its quality. Such extreme differences, however, are not common, because the worst quality of copper is seldom or never drawn in the form of wire ; nevertheless samples of wire come to hand varying in conducting power between 50 per cent. and 97 per cent. that of pure copper. A year or so ago I tested pieces of several samples of the same sized leading wires for use in an installation of street lighting, and found in the best sample the specific conductivity of the copper to be 96 per cent., and the H. P. calculated to be wasted in the wire strand, with the system in which it was employed, at the rate of 1·3 H. P. per mile length. The worst sample—obtained from another source at a saving, I was told, of £10 per mile in the price—had a specific conductivity of only 63 per cent., while the power wasted in the wire strand was at the rate of 2 H. P. per mile, or 0·7 H. P. per mile more than with the first sample of wire. Now 1 H. P. accounted for electrically costs in London at least 1d. per hour, and, working an average of 10 hours a day, 1 H. P. costs £15 per year; so that the saving of £10 in first cost of the wire would be obtained at a cost of over £10 per year afterwards in extra H. P., a rather high rate of interest. Such instances of false economy may easily happen in the early stages of any new industry, but disappear when those who have the working of it come in time to understand better the physical principles which underlie their business.

As regards the substance for surrounding the conductors, the best and cheapest of all is the air; and when leads can be stretched in air the best form would probably be a copper band which would present a large radiating surface. But in practice, unless in the case of subways, this is impossible and we are reduced to the next best thing, viz., copper wire, strand, or bar enclosed in a covering of insulating material. In the judicious choice of this material much of the success or failure of an electric lighting system may depend. Vulcanised india-rubber is perhaps the best substance at present employed, being specifically so good an insulator that a comparatively thin coating is sufficient, if mechanically perfect, and it is diathermanous at the same time; besides which, it is not injured by an accidental heating up to the boiling point of water. Gutta-percha is inferior to india-rubber in point of diathermancy, and in the event of the conductor getting too warm, might become soft and allow the wire gradually to press itself through it. The method of enclosing the wire in a tube of lead is open to objection on account of the obstruction which the lead offers to the radiation of heat developed in the interior. It has however the advantage of keeping the wire dry, and so preventing the development of faults.

When inferior insulating materials are used, they are sometimes applied in greater thickness upon the copper conductor, with a view to make up by mass for their specific inferiority. This would be an advantage in wire destined for telegraph purposes, but it is the reverse for electric light leads. Greater thickness of an inferior insulating material means generally increased heat of the conductor, and therefore increased waste of power. The effect of specific inferiority of materials, whether copper or insulation, may be electrically met by taking a greater section of copper. In so far as the insulation is concerned, there may be a saving in first outlay in employing a little more good copper and a cheaper insulator; but this does not hold good as regards inferior conductivity of the copper itself, as the price of copper is not by any means proportional to its specific conductivity, and an increase in the section of copper to eliminate the effect of low conductivity, would increase the first cost of a lead made up with it much beyond the price of one containing copper of high conductivity. The cheapness of a lead is not measured by its first cost. A saving in first cost may be effected by employing inferior materials, but when this is done, it may, as a rule, be taken for granted that in the end the saving is more apparent than real.

The behaviour of an electric light lead sometimes differs from that of a telegraph core when faulty; because an injury which constitutes a fault for the one may not necessarily be a fault for the other. Actual contact, or "dead-earth," is, of course, a fault for both; but a fault, having an electrolytic resistance, such as might render a telegraph line actually unworkable with the weak currents and higher conductor resistance used in telegraphy, sometimes disappears completely under the action of the higher electromotive forces and stronger currents used in some systems of electric lighting. With a weak testing battery, for instance, I have known the damp and dirt of an electric lamp show an apparently total want of insulation, which was entirely without observable effect upon the efficiency of the lights when the system was at work. On the other hand, there are incipient faults which a weak testing battery fails to discover, but which the light current may readily find out and develop into something bigger. Immersed in water, as sometimes happens in leads which are buried, faults in the wires may give rise to unsteadiness of the lights without causing their interruption. This unsteadiness is caused by alternate decomposition of water in the faults, the bubbling out of the gas, and the readmission of the water. Daily testing for insulation of leads would be a good rule in the practice of every electric lighting company whose business includes public lighting.

Electric light companies are now, and will be for a long time, competitively on their trial, and those consult their own interests best who avoid risk by employing the best procurable materials and the best and most careful workmanship; for whatever may be the actual cause of any breakdown in public, whether the leading wires, the lamps, the dynamos, or the engines be in fault, the public simply attributes it to the "system of lighting," and promptly condemns the "system" accordingly.

There are two electrical tests which should be made before adopting any light lead, viz.:—(1) Conductivity of the copper, and (2) insulation of the covering. Instruments suitable for making these tests can be procured at the expense of a few pounds of any respectable instrument maker, and should form an indispensable requisite of every electric light company's works.

Electric light leads are very subject to accident in erection. They sometimes have to undergo a good deal of bending, many a sudden pull and strain, and not unfrequently a sharp accidental blow with a hammer, or other sudden shock. All these accidents the wire should be capable of withstanding uninjured, and its capacity for doing so should be proved by certain simple *mechanical* tests of the insulating material.

1. Every covered wire, stripped of its outer covering of lead, tape, or brading, should bear repeated bending without showing cracks; but the test for flexibility, although a necessary one, is not conclusive, and it may be deceptive. There are two kinds of flexibility, the flexibility of a cane or steel spring, and the flexibility of dough or putty. The latter is a very objectionable kind of flexibility when found in conjunction with the insulation of a leading wire.

2. The sample of covered wire, say, 2 or 3 feet long, should be stripped of as much of its tape or brading or lead as possible, and the copper wire removed. This may be done by making a longitudinal slit with a sharp knife down one side. The empty tube should then be hung up to a support, and a weight attached to its lower end. With regard to the weight to be hung upon it, this depends upon the sectional area of the insulation, which can be approximately allowed for by weighing the sample and hanging upon it a certain number of times its own weight. Some india-rubber breaks at about 300 times the weight of a 2-feet length. Some gutta-percha bears considerably more than this. But without pushing the test so far as this, it is generally sufficient to hang 2 or 3 lbs. upon the material, and leave it hanging for 24 hours. If at the end of this time the material shows no cracks, it may be accounted satisfactory.

3. The remaining mechanical test is best made by removing the lead, tape, or brading, and after laying the naked core on an anvil, or other solid bed, to strike it a smart (but not a crushing) blow with a small hammer. If the material be good and sound, it will remain unbroken. Good india-rubber recovers its shape immediately. Gutta-percha is slower in recovering. When old, both india-rubber and gutta-percha split and crumble beneath the blow. When any splitting or chipping is observed it is a sure sign that an accidental blow with a hammer might produce a similar but unseen fault which might cause serious future annoyance in a light circuit, and such samples of covered wire should be summarily rejected as worthless.

Electrical Science Abroad.—We read in the *Operator* that, during the meeting of the New York Electrical Society, on December 15th, the proposition to establish a circulating library was referred to the executive committee, with full power to act in the matter. The president announced that Professor Mayer, of Stevens Institute, had promised to lecture before the society during January. Mr. Robert Spice, the lecturer upon electricity in the Cooper Union series, favoured the society with an interesting lecture on static induction, eliciting frequent applause by his skilful experiments. Nine new members were elected. The society is rapidly growing in membership and popularity.

REVIEW.

Useful Rules and Tables relating to Mensuration, Engineering, Structures, and Machines. By W. J. MACQUORN RANKINE. Sixth edition, thoroughly revised by W. J. Millar, C.E. With Appendix; Tables, Tests, and Formulæ for the use of Electrical Engineers by Andrew Jamieson, C.E., F.R.S.E. London: Charles Griffin and Company, Exeter Street, Strand.

THE line of demarcation between mechanical and electrical engineering is, we think, actually very marked, although it would be difficult to point out exactly where the line should be drawn. As a matter of fact an engineer who deals with the laying, testing, &c., of submarine cables and with electrical work generally, very rarely if ever engages in the construction of bridges, &c., and on the other hand the civil or mechanical engineer does not, except under very exceptional circumstances, deal with telegraphic matters. We think, therefore, that the combination of information contained in the work before us, especially when we consider its high-class character, is almost as incongruous as would be a work on "Surgical Appliances, with useful Information on Cookery." The two branches of engineering, although undoubtedly allied, are practically distinct, and we think Mr. Jamieson would have done better if he had given the electrical and telegraphic world the benefit of his great and varied experience in the shape of a separate handbook.

The information which Mr. Jamieson has collected together is really most judiciously chosen, and as he very freely gives references to other works for the benefit of those who wish to obtain more information on the particular subjects referred to, the utility of the work is certainly much greater than might at first appear.

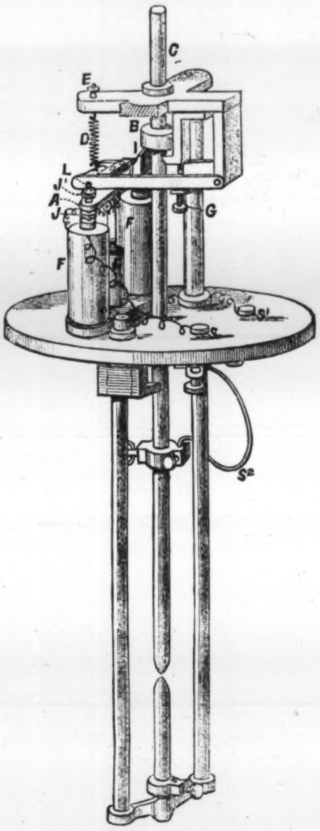
In cases where the localisation of faults and the testing of cables is dealt with the information is put in a very practical manner, the forms for entering the tests as actually used in practice being exemplified. A list of various recent submarine cables with their electrical data affords much really useful help. For testing purposes the connections of the instruments are given in a concise and clear way, whilst the necessary explanations are made brief without being unnecessarily short. Whilst strongly recommending the work, which includes valuable electric lighting formulæ, &c., we must repeat that we think it a pity that the electrical information had not been published in a separate form; we venture to say that if it had, the first edition would not have been the last.

LEVER'S ARC ELECTRIC LAMP.

IN the ELECTRICAL REVIEW of April 22nd we illustrated and described in our abstracts of specifications a form of arc lamp devised by Mr. Chas. Lever, of Manchester. This gentleman has, however, invented another form of lamp, which he patented on the 3rd of May last. In its normal condition—that is, prior to the passage of an electric current—the carbon rods do not touch each other as in most other lamps, and it therefore resembles in this respect Lontin's modification of the well-known Serrin apparatus. Again, instead of employing a solenoid or electro-magnet in the main circuit for forming the arc Mr. Lever depends upon an arrangement which will be made clear by referring to the following description and illustrations of his lamp as now in action at the Crystal Palace Exhibition:—

In the general view of the complete lamp, A, is the armature, L, a lever, and D, a spring; E is the nut for adjusting the tension of the spring, D, and I is a projection attached to the lever, L, which cants or tilts the clip, B, by means of spring, D. G is the set screw for adjusting the length of arc. The iron screws, J J, with large heads passing through the armature, A, serve as adjustable polepieces, and can be secured by means of lock nuts, J^1 J^1. R is the dash pot and S S^1 are the binding screws. The current entering, say, at the positive binding screw, S, passes through the insulated flexible wire or cable, S^2, to the upper carbon-holder, C, from thence through the arc and lower carbon and through the frame of the lamp to negative binding screw, S^1. The side rods are insulated from each other; and the ends of the coils of the electro-magnets, F F, are connected to the binding screws, S S^1, thus placing the electro-magnet, F, in derivation from the arc.

When the lamp is ready for action, the carbon points are separated by means of the spring acting on the armature lever. The current must therefore necessarily take effect upon the electro-magnets, which, becoming powerfully magnetic, overcome the force of the spring, thus loosening the clip and allowing the upper carbon to fall by gravity into contact with the lower one. As soon as this occurs and the main circuit completed, the spring overpowers the weakened magnetism of the electro-magnets and raises the upper carbon to its regulated distance, thus forming an arc of given length.



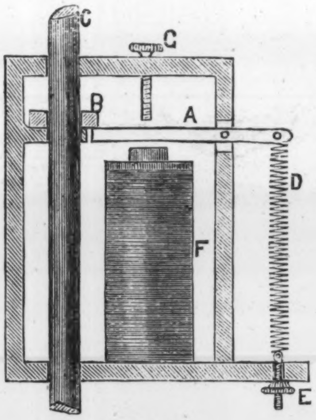


FIG. 1.

This action will continue until the carbons are consumed, the spring continually drawing up and allowing to fall the upper carbon, as controlled by the electro-magnets. A diagrammatic sketch of the lamp is seen in fig. 1.

A simpler modification of lamp is that shown in figure 2, where two springs, B B (fixed to two screws, I, which can be adjusted as required by their nuts in the casting, H, through which the upper carbon-holder, C, slides) alone are used, and which by their elasticity impinge on the sides of the said carbon-holder, C, and raise the carbon point to the required distance for the production of the arc, this distance being regulated by two set screws, G G, acting on the said springs, B, and limiting their upward movement. The shunt electro-magnets, F F, attract these two springs, B B, which in this case are made of steel and have soft iron pieces, B^1 B^1, fixed thereon, and which act as armatures. The carbons in the lamp are separated before the current passes, as already described.

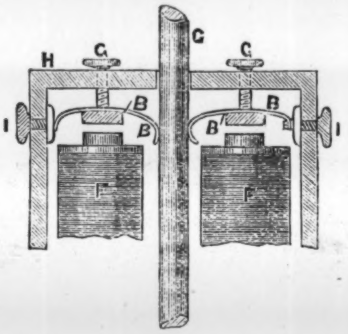


FIG. 2.

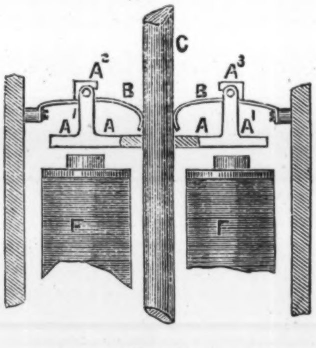


FIG. 3.

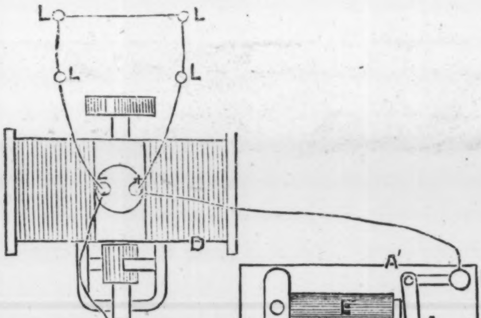


FIG. 4.

Fig. 3 shows an arrangement in which the springs, B B, are coupled or connected to an armature, A, common to both poles of the electro-magnet, F F, by means of uprights, A^1, which have pins, A^2, which are free to slide in slots in the brackets, A^3, fixed to the springs, B, so as to allow for the radial motion of the springs, B, when the armature is attracted. We have already said that when the lamps are first put in action their carbons are all separated, and therefore the current passes through the shunt coils. These have a high resistance, and the dynamo machine, unless it is shunt wound, cannot generate sufficient current to excite its field magnets. Mr. Lever, to get over this difficulty, has devised an automatic apparatus, which has the effect of short-circuiting the generator through a shunt of moderate resistance, until the current has attained a determined strength. The shunt circuit is then broken and the current passed into the lamps, with the effect of actuating their magnets and establishing the arcs. Figs. 4 and 5 illustrate this apparatus. From the terminals of the generator are two circuits, one comprising four lamps, L L, and the other the automatic shunt. This comprises an electro-magnet whose coils, E E, have a resistance about equal to that of the lamps, a pivoted armature, A, and a sliding contact, C, shown to a larger scale in fig. 5. At first the course of the current is through the magnet coils, the fixed portion of the contact, then across the armature and back to the generator, as shown. As soon, however, as the armature is drawn up to the magnet one part, C, of the contact-piece slides off the other, S, and the circuit is broken, whereupon the whole current flows through the lamps.

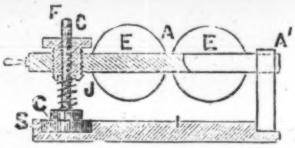


FIG. 5.

Mr. Lever's lamps are simple and cheap to manufacture, and although for arc lamps the cry is "still they come," and notwithstanding the fact that only the fittest will survive, we venture to think that with judicious and energetic management the lamp we have described will secure a place amongst the survivors.

A New Scientific Journal.—We notice in the American press that a new journal is about to make its appearance. A joint stock company has been formed, with abundant capital, for the publication of *Science*, an illustrated weekly journal. The president of the company, and, indeed, founder of the enterprise is Prof. A. Graham Bell, and the editor who has been chosen is not a physicist but a biologist. Mr. Samuel H. Scudder, the president of the Boston Society of Natural History, and well known as a specialist in entomology, has resigned his position as assistant librarian of Harvard University, to take charge of *Science*. The journal will be published in Cambridge by the young Harvard publisher, Mr. Moses King, and *Science* will present itself to the public early this year. In several respects this new journal will differ from every other attempt in America to produce a scientific journal. At the outset it acquires, says the *Boston Daily Advertiser*, the three requisites of any successful journal—ample capital, editorial and contributing support of acknowledged ability, and competent business management. It asks for no contribution of articles or news without offering a fair compensation for them. It will accept no announcements or reports of new inventions or improvements, excepting for their scientific merits, and then only on the same basis as it admits other reading matter, no pecuniary or equivalent considerations influencing decision in the slightest degree. No advertisements, even, will be admitted in the regular advertising columns to which any reasonable objection could be made by scientific men; the editor regularly scrutinising the advertisements with the power of rejecting them.

TO CORRESPONDENTS.

No notice can be taken of anonymous communications. Whatever is intended for insertion must be authenticated by the name and address of the writer, not necessarily for publication, but as a guarantee of good faith.

Letters, &c., for the "Correspondence" columns should arrive not later than Tuesday morning if they are desired to appear in the following number, such communications to be addressed to the "Editors," ELECTRICAL REVIEW, 22, Paternoster Row, London, E.C.

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CORRESPONDENCE.

A New Theory of the Electric Transportation of Force.

I send you a short sketch of a new theory of the electric transportation of force, as I have expounded it in the session of the Electrotechnical Association on the 19th of this month, with the request that you will kindly publish a translation in your esteemed journal, and, if you consider it advisable, to have it discussed by one of your scientific referees.

The theory of the electric transportation of force proposed by Marcel Deprez sets out with the fundamental view that the force proceeding from the primary machine is partly converted into heat and partly reproduced by the secondary machine as utilisable work, and comes to the conclusion that the electric work is proportional to the relation between the speed of the secondary and of the primary machine. According to my view this fundamental notion is so far inaccurate, as a loss of power by the heating of the circuit does not take place. The power which is lost serves rather to overcome the passive resistance present in the transmission—*i.e.*, to set the secondary machine in motion. The expenditure of power necessary for this latter purpose (transmission work) is measured by letting the secondary machine run empty and then ascertaining simultaneously the motive-power consumed by the primary machine. If we call the latter A_0, the resistance of the circuit R, and the strength of the current corresponding to the transmission work T_0, then

$$A_0 = R \,.\, T_0^2.$$

If the secondary machine is now loaded with the performance of work, the strength of the current and the consumption of force in the primary machine are altered, and we have—

$$A_1 = R \,.\, T_1^2.$$

If we deduct from the total work, A_1, the transmission work, A_0, we have the utilisable work—

$$A_2 = A_1 - A_0 = R\,(T_1^2 - T_0^2).$$

Consequently the utilised effect—

$$N = \frac{A_2}{A_1} = \frac{R\,(T_1^2 - T_0^2)}{R \,.\, T_1^2} = \frac{T_1^2 - T_0^2}{T_1^2}.$$

Faithfully yours,

W. Christiani,
Imperial Telegraph Inspector.

Berlin, W., *December* 21*st*, 1882.

Electrical Accumulators.

In reply to your correspondent, Mr. B. Unwin, I am happy to supply some particulars relating to the application of secondary batteries to arc lighting.

The Sellon-Volckmar accumulators which were shown at my lecture at Limehouse were of the 1 horse-power type, capable of furnishing a current of 20 ampères for 15 hours, or 30 ampères for 10 hours; in other words, their capabilities may be expressed by 300 ampère-hours.

Since this accumulator adapts itself to any requirements for high or low currents it is necessary that the circuit should be properly arranged.

An arc lamp, to work with accumulators, must be accurately adjusted, the carbons must be fed gradually and not by sudden jerks.

The accumulator in question is capable of giving a current of over 100 ampères for a short time, and this current would work great mischief in some lamp fittings, if allowed to flow at that rate; thus, if the carbon rods were to touch each other, there would be a tendency for the current to make the carbons incandescent throughout their whole length, and the result would be a rapid discharge of the accumulators, and great diminution of light.

Until a new arc lamp is devised in which the carbons are prevented from touching each other, it will be necessary to insert such a resistance in circuit which will prevent a too powerful flow of current, and this latter method I adopted with the Pilsen lamp, which gave a perfectly steady light with 10 ampères and 50 volts.

Yours respectfully,

A. Reckenzaun.

Poplar, *December* 27*th*, 1882.

Society of Telegraph Engineers and of Electricians.

From the tone of "Fareham's" letter in your issue of to-day, many may be led to infer that the "question of supplying provincial members of the society with books from the library" had at some time or another been brought before the Council of the Society, and "had again passed unnoticed."

Should there be any of your readers who have had that impression, permit me to say that I have received no communication whatever on the subject, and in the absence of any desire being shown to alter the rules of the library in order that books may be removed, I have, of course, not considered it my duty to bring the matter before the Council.

I am always pleased to receive suggestions relating to the management of the library, and endeavour, where possible, to meet the requirements of the members of the society.

Faithfully yours,

A. J. Frost,
Librarian.

December 30*th*, 1882.

Inventors and Inventions.

Do you not think, considering the present state of affairs in the electrical world, that it would aid much in the advancement of the science if you made a special point of giving, from time to time (say, once a month), hints as to the direction inventors should turn their minds?

From your position you have, as it were, a bird's eye view of affairs and your suggestions might be the means of saving much loss of time and brain-work amongst inventors who have not the same means of knowing in what direction improvement is most needed.

Yours faithfully

C. Scott Snell.

[Presuming we could do that which our correspondent desires, we think him somewhat inconsiderate in wishing to throw the burden of inventors' loss of time and brain-work on to our shoulders. Although always desirous of doing all in our power towards the development of electrical science, our time must be employed otherwise than in posing as guides to invention.—EDS. ELEC. REV.]

Electro-motors.

Relying on your well-known impartiality, I ask you kindly to give me space for a few remarks on Prof. Thompson's reply to my letter on electro-motors.

As my letter is before you as well as Prof. Thompson's reply, you, and such of your readers that care to compare the two, will be able to judge whether I am right in saying that Prof. Thompson has not addressed himself to the points raised in my letter, and whether he has not rather been at some pains to refute what I never stated.

I have also to complain a little of the tone he has adopted. There is evidence of an amount of irritation in his letter which, I think, is unsuited to scientific discussion, and such a display emanating from one of Prof. Thompson's high and well-merited reputation is calculated to discourage legitimate discussion of an interesting subject.

He takes me to account for having, as he thinks, made the mistake of confounding together the efficiency "of a motor *per se* (*i.e.*, the ratio of the mechanical power it performs to the electrical power it absorbs) with the efficiency of a system for transmitting power by electricity." I beg Prof. Thompson's pardon, but I did not make this mistake, and the wonder is why he should think so, as my letter contains nothing which could justify him to assume anything of the kind. But, he having this erroneous impression on his mind, there follows as a consequence a whole string of arguments more or less incongruous and irrevelant to the real point at issue. He improves his opportunity and makes these arguments a vehicle for some hard expressions, saying, in effect, that I know nothing about it and had no business to meddle with it.

When I wrote that letter I was not aware that I was ventilating any difficulty of mine. Let me assure Prof. Thompson that I am in no difficulty whatever. I think I may fairly describe my letter as suggestive rather than solicitous. So far from confounding the two efficiencies together, it was the very gist of my letter to keep them separate, saying, in effect, that while in a dynamo machine the electrical efficiency and its effectiveness were synonymous terms, they were not so in motors. To make my position clearer, I shall, with your permission, illustrate it by describing an actual experiment with two motors, Nos. 1 and 2. They were of about the same weight. The source of power was a battery. Motor No. 1 was of a resistance suitable to the battery and its E. M. F. This motor, when running free, reduced the current from 5 ampères to about 0·8 ampères. Its electrical efficiency was, therefore, very high. To test its capacity for work, it was made to lift a certain weight, which it did in a certain time. Being thus loaded, the speed was now about half to what it was when running free, and the current rose correspondingly. Motor No. 2 was constructed on a different principle. Its resistance happened to be less, and it was therefore less suited to the battery. The current fell, when running free, from 6·5 ampères to about 3·5 ampères. Its electrical efficiency was, therefore, less than that of No. 1; but in being loaded it lifted the same weight in less time. By dint of winding its armature to a resistance suitable to the battery, its electrical efficiency could be made as great as that of No. 1. Its lifting power would thereby be still more increased. So, here are two motors of about the same weight, of equal electrical efficiency, and very unequal effectiveness or efficiency, *per se*, as Prof. Thompson chooses to call it.

Having my own means and apparatus to test the effectiveness of motors I went to Prof. Thompson's lecture to learn how this effectiveness was tested by others, with a faint idea of seeing different dynamometers brought into use. I was disappointed in that; but it is not for me to say what points Prof. Thompson should touch upon in a lecture on a subject of such magnitude. The only experiment where a motor was put to lift anything did not come off, as the motor (a small Griscom) refused to move.

I disclaim any idea of discrediting Prof. Thompson's own motor, which, for ought I know or care, may be the very best ever invented, or of discrediting his theory of transmission of power by a system. I have not said a word about either, and Prof. Thompson's outburst of indignation seems to me singularly out of place.

I have now to refer to the last passage of his letter which I shall have to quote in full. He says, "Lastly, I will put one point to Mr. Immisch. He says that when a motor was allowed to run, 'the current itself, as measured by a current meter,' was 'necessarily falling off.' Now, a falling-off in the current could only arise from one of two causes, either from an increase in the resistance of the motor, or from an opposing electromotive force in the motor itself. Which does Mr. Immisch suppose it to be? He surely ought to have made the tests necessary to convince himself which it is, in the case of his own motor before he rushes into print with criticisms on the theory of motors in general."

Prof. Thompson has no warranty that I did not make the tests he speaks of before I "rushed into print." As to the diminution of current when the motor is running I have only to repeat what I distinctly stated before, that I do not believe in this counter E. M. F., and I gave my reasons for disbelieving in it. I recommended a simple experiment, which seems to me to prove conclusively that no opposing E. M. F. is set up in a motor. This experiment may be varied by substituting between the brushes, in place of a tension meter, a small incandescent lamp. When the motor is kept at rest there is, owing to the great resistance of the lamp and the small difference of potential between the brushes of the motor, only a feeble current passing through the lamp. When the motor is allowed to run the lamp begins to glow, its brilliancy increasing with the speed of the motor. Here is then evidence of energy which was not there before. It is no newly-created energy, but the original energy carried by the circuit and generated in the battery. It becomes changed in nature, if I may use that expression, and as it makes its appearance between the brushes of the motor in the form of increased E. M. F., its other component, the current, must necessarily be falling off. This, of course, implies that the same amount of zinc is consumed in the battery whether the motor is running free or whether it is loaded or at rest. Is Prof. Thompson prepared to maintain that when a motor of an electrical efficiency of 90 per cent. runs free that the amount of zinc consumed in the battery is only one-tenth to what it is when the motor is at rest? If he can prove that he will make me a convert to his theory of counter electromotive force; if not, he will perhaps own that my explanation is the most natural of the two. Apologising for the length of this letter,

I am, dear Sirs,
Yours very faithfully,
Moritz Immisch.

119, Toriano Avenue.

Electrical Instruction.

I observe with surprise that you have lent your columns to what appears to me a most unwarrantable and injurious attack, under the above heading, upon an institution which, for many years past, has undoubtedly done much to raise the standard of scientific and practical efficiency amongst those who have to carry into effect the various applications of electricity. By giving insertion to the spiteful communication of "Caveat Emptor," you have adopted a course which hitherto, I am happy to say, has been unknown in English scientific journalism: that of placing in the hands of anonymous malevolence a weapon against which the most conscientious and successful endeavour can afford no safeguard, since its purpose is not that of open and rational criticism, but simply to inflict a stab in the dark.

None of your readers, with the reference before them to your issue of the 16th ult., can have failed to perceive that the depreciatory recommendation of "Caveat Emptor" is intended to apply to the "School of Telegraphy and Electrical Engineering," in Prince's Street, Hanover Square, recently described by the editor of *Knowledge* as "the largest and the only general electrical engineering school." With a logical incoherence, which perhaps affords a clue as to the nature of his unsatisfactory relations with this establishment, your correspondent says: "I know the place well and therefore do not name it!" May we hope that he will not be equally reticent as to his own name! It is possible that "the place" may know him well, too.

I have no pecuniary interest in the "School of Telegraphy and Electrical Engineering." If I had I should probably, instead of making this protest against the atrociously bad taste and impropriety of your correspondent's letter, take legal steps to arrive at the personality of "Caveat Emptor," with a view to affording him (or, failing him, yourselves, Gentlemen,) the opportunity of justifying or substantiating, if possible, the imputations implied and insinuated in that letter. The grounds that I have for writing to you on this subject are, that for a long time past I have been intrusted with the general direction of the theoretical studies at the above institution, especially in relation to electricity as a branch of physics in close connection with chemistry, and that I have also undertaken the superintendence of certain practical and experimental work, such as the construction and testing of incandescent lamps and secondary batteries, in which I have had a considerable amount of experience. I know also that my colleagues, who severally have undertaken to give instruction in electrical manipulation, signalling, and practical testing; in general engineering and in pure and applied mathematics (with special reference in both cases to the practical applications of electricity), are men of recognised ability and reputation in their various departments. I know, moreover, that no expense or trouble has been spared to obtain all the machines and appliances employed at the present time in electrical work and in research; and I consequently know something of the opportunities possessed by the students at this school for obtaining a practical as well as a theoretical knowledge of electrical engineering. On the other hand, I should state that until pupils have passed the first grades of instruction and exhibited a certain amount of application and proficiency, they are not allowed to amuse themselves, to the detriment of others if not to their own, with prime-motors, dynamo machines, arc and incandescent lamps, or powerful secondary batteries. Before they can do *work* with such appliances, it is necessary that they should have a knowledge of elementary principles and of *formulæ*, which, in my judgment, every man should be able to derive from such principles, and from certain fundamental *data*, instead of merely attempting to apply them empirically and unintelligently. Of course there always are, and always will be, some representatives of the class which furnishes the "hard bargains" to this and to all other educational and training establishments—men who have no application, or to whom one is forced to say: *intelligibilia, non intellectum adfero.* Such men, finding that they are no credit to themselves, often find a sort of consolation in bringing into prominence the fact that they are no credit to their instructors. These, I am happy to say, are the exceptions; for in all the applications of electricity, at home and abroad, some of "our men" are to be found amongst the foremost workers, and their acquirements in many cases have received substantial recognition. I may add that the communications which from time to time have been addressed from the school to certain of your contemporaries afford some indications of the fact that practical electrical engineering is not altogether neglected at that establishment.

I am, &c.,

Desmond G. Fitzgerald.

December 31*st*, 1882.

[We freely accord space to Mr. Fitzgerald's communication, particularly as he deems that we are in fault in having published the letter of "Caveat Emptor" in our last issue. If we have, as Mr. Fitzgerald says, "placed in the hands of anonymous malevolence a weapon, &c.," we exceedingly regret it, and we would remark that our so doing could only have been due to inadvertence, for we have no personal knowledge or experience of the teaching carried out in the school to which Mr. Fitzgerald points, and certainly bear the school no ill-will. Indeed, in this connection we may mention a notice of the said school in an article which appeared in our issue of October 21st, 1882 (p. 309), in which we say: "Then we have amongst others devoted to the complete education of an electrical engineer, the School of Telegraphy and Electrical Engineering, which has, perhaps, been established a greater number of years than any others of an *important* character." Granted that Mr. Fitzgerald's references to ourselves are warranted, we distinctly aver that the publication of the letter of which he complains could even then be only an error of judgment or taste, and for any such possible error we have already expressed regret, and we now pass on to the other portions of that gentleman's communication.

The encomiums which he pays to the school are doubtless well-merited, and we have no desire to detract one tittle from what he says; indeed, we shall avail ourselves of the first opportunity of verifying his statements, but we fear that his intimate connection with the institution, although, as he says, not of a pecuniary character, may to some extent weaken, rather than strengthen, the force of his words. We do not think the closing remark of Mr. Fitzgerald's letter is happy, at least, if he includes answers to questions asked at the examinations of the City and Guilds Institute and published in a contemporary; for although the subject of electrical engineering may be thoroughly well taught at the school, yet we venture to think that certain inaccuracies contained in some of those answers do not point at all to that conclusion; possibly, however, Mr. Fitzgerald refers to articles which we may not have seen.

One word more. Our correspondent in his letter says, "you have adopted a course which hitherto, I am happy to say, has been unknown in English scientific journalism—that of placing, &c." Does Mr. Fitzgerald forget the Fyfe-Main incident which occurred, last year, with a contemporary, which has always been closely identified with our correspondent's name? If so, his memory is at least a convenient one.—EDS. ELEC. REV.]

C. V. WALKER, F.R.S.

ON the 24th December last Mr. Charles V. Walker, F.R.S., breathed his last, the cause of death (in his 71st year) being due to weakness of the heart's action. We believe he became first of all prominently known in scientific matters by his translation of De la Rive's admirable work on electricity and his connection with the famous Dr. Lardner. He had been telegraph engineer to the South-Eastern Railway since 1845. Science owes much to the labours of the deceased gentleman, and the following may be tabulated amongst the more important:—

1848. Movable studs for use when earth currents prevail. Protector against lightning, and a compound needle.
1849. Movable coils for use with earth currents, and the platinised graphite battery.
1850. Improvements in insulators.
1851. Single stroke bell and compound ringing key.
1854. Galvanometer-semaphore.
1863. Single-wire electro-magnetic telegraph semaphore.
1866. Passenger and guard communicating apparatus.
1874. Train describer.
1875. Double-action electric repeater.

The following are some of his literary productions:—

1837. Electrotype manipulation.
1842. The effects of a lightning flash on the steeple of Brixton Church, and observations on lightning conductors generally. Memoir on the difference between Leyden jar discharges and lightning flashes.
1843. *Electrical Magazine* (commenced).
1845. On the electricity of paper-mills and an analysis of friction.
1850. Electric telegraph manipulation.
1865. Train signalling in theory and practice.

Time signals appear to owe their origin to a scheme set on foot by Mr. Walker and the late Astronomer-Royal, Sir G. B. Airy, in 1849.

On the 13th October, 1848, Mr. Walker sent the first submarine telegram from a ship two miles off Folkestone to London Bridge, the shore-end of the cable being connected to one of the land-lines.

So long ago as 1838 this prominent electrician recognised the necessity of concentrating scientific thought and investigation upon the subject of electricity, and therefore took an active part in the then newly-formed London Electrical Society, of which he was secretary in 1843. He was made a Fellow of the Royal Society in 1855.

In 1876 Mr. Walker was President of the Society of Telegraph Engineers and of Electricians, and we recommend to the notice of our readers his very interesting address published in the above society's journal for that year.

Although but little heard of during late years, Mr. Walker's life has been spent in doing earnest and conscientious work to make clear the path of others, and his death severs another link in the weakening chain which connects the present generation of electricians with the old school of the pioneers of electrical science in England.

E. Fox & Co., of Millwall.—The business of this firm of wire manufacturers has been turned into a limited liability company, under the title of Edwin Fox & Co., Limited, and the City offices are at 5, Great Winchester Street, E.C.

NOTES.

Electric Lighting.—We have received from the Hammond Electric Light Company the following information :—

"During the past year the Hammond Electric Light and Power Supply Company, Limited, have thrown themselves very thoroughly into the work connected with town lighting in order to pave the way for obtaining a share of the work of corporations when powers were obtained under the Electric Lighting Act. At Chesterfield they have continued the lighting of the whole town with Brush lights and Lane-Fox incandescent lamps upon the same circuit. While the Brush lights have given great satisfaction the Lane-Fox lamps have been almost universally condemned, but during the last month a very great improvement has taken place in this lighting, due to the supply of a greatly improved Lane-Fox lamp, and at the present time this installation is in a much more satisfactory state than it was a year ago. A large town installation has also been made by this company at Brighton, where now about 50 Brush arc lights are running from their central station. Town lighting was also done by this company during the exhibitions at Peterborough, Worcester, Tynemouth, and Bradford, the gold medal having been awarded to this company at Bradford, and the chief medal at Peterborough and Tynemouth. Various extensions have been made to the plant already erected by them. At McClure's of Stockport a 16-light apparatus has been exchanged for a 40-light apparatus. At Leslie & Co.'s, shipbuilders of Hibburn, also a 16-light apparatus has been exchanged for a 40-light apparatus. R. and W. Hawthorn, Newcastle, have taken 16 more lights. Edwards and Son, South Shields, a 16-light installation. Palmer's Shipbuilding Company, 16 more lights ; Stamers Close Steel Works, 16 lights. This company also undertook the lighting of the Mersey Tunnel, but the working of the Lane-Fox lamps there was not very successful. A town installation has also been made by them at Cockermouth and Portsmouth.

"The greatest stride, however, that has been made by this company during the year has been by the acquisition of the Ferranti machine, presented to the public under the joint names of Sir William Thomson, S. Z. de Ferranti, and Alfred Thompson, and which, it is plain, will far eclipse all other machines in the market. One of these machines has already been erected at the works of Messrs. Copestakes, Hughes, Crampton and Co., at Nottingham, and important orders are on the books of the company in other directions. A machine to run 5,000 lights, and weighing about two tons, is on the point of being finished ; and if this works with the efficiency claimed for it, it will revolutionise the whole question of incandescent lighting from a central station. Applications under the Electric Lighting Act were made for every borough in England ; but having got into friendly relations with a large number of corporations, the company have contented themselves with withdrawing their applications in order to become the contractors for the work of corporations."

We understand that several artists in the West End—amongst them Mr. Frank Dicksee—have combined for the purpose of having their studios illuminated at night and when otherwise necessary by means of incandescence electric lights.

The Australasian Electric Light and Power Company has taken the sole agency for the Ferranti dynamo-electric machine in the Australias, and the first machine will be sent out shortly.

The Edison Company has been the first to establish a central station for the distribution of the incandescent light to all classes of consumers from a common centre and the registration of the consumption by electric meters. The company's station on Holborn Viaduct was intended to show the practicability of supplying electricity in a manner analogous to that universally adopted in the case of gas ; but the company contemplates, when the necessary powers under the Act of last session shall have been obtained, lighting a far more extended area than that at present covered by them. We are informed that the experience gained since the starting of this station, as to the fundamental requirements of this class of installation and the practical difficulties to be overcome, has been of a valuable nature ; and the company believes that when an adequate area shall have been covered by the requisite net-work of conductors, and various recent improvements in the system shall have been introduced, central station lighting will be in a position to return a satisfactory dividend on the capital invested, even at the present price of London gas. The financial prospects of the company from the rent of domestic motors are even more encouraging. In the isolated plant department of their business the company has made installations in several factories, public buildings, ships, &c. The principles which have guided the company in this class of work have been to undertake no installations save at remunerative prices, and to carry out all work in strict accordance with those principles of electrical engineering which have been laid down by Mr. Edison as essential to the *permanent* efficiency of an installation. The company has, during the year, reduced the price of the incandescent lamp, in quantities, from five shillings to four shillings each and a further reduction is now contemplated. Mr. Edison has of late taken out a fresh series of patents covering many important improvements in various parts of the system. Amongst the main points of these improvements are modifications in the dynamos by which the sustaining power of machines of the present sizes will be very greatly augmented, and the production of lamps of a resistance never before attempted.

On Saturday evening the exterior of the offices of the *Taunton Courier and Somerset County Herald* were illuminated with the electric light. The lamp used was Brockie's arc light of 200 candle-power, worked by a Gramme dynamo machine which gave on an average 900 revolutions a minute, and was driven by the engine which works the printing and folding machines in the establishment. Mr. W. W. Easton, of the Whitehall Foundry, Taunton, supplied the light and carried out skilfully the whole of the arrangements.

On Wednesday evening, the 20th December, in conformity with the statute, a special meeting of the Camberwell Vestry was held in the Vestry Hall, Peckham Road, to consider the question of adopting the Electric Lighting Act in the parish. Mr. E. Dresser Rogers presided. Mr. Middlemass moved, "That the consent of the vestry, as the local authority having jurisdiction within the area of the parish of Camberwell, be given to an application to be made to the Board of Trade by this vestry for a licence to supply electricity under the Electric Lighting Act within such area or areas as may hereafter be determined upon by the vestry." The problem before the vestry, he remarked, was either to consent to an application of the vestry to supply electricity in the parish, or hand the parish over to the Metropolitan Brush Company, that being the only company that had followed up their notice with plans for a Provisional Order. This company had scheduled Old Kent Road, Commercial Road, Southampton Street, New Church Road, Rye Lane, and from Camberwell Road to Deptford ; but nothing was said of the price to be charged. He asked the vestry to pause before handing the parish over to a monopoly. (Applause.) The motion having been seconded and supported, a discussion ensued between Messrs. Salter (who opposed the motion), Mr. Mulley (who, in consequence of the small number of members present, moved the adjournment of the meeting for a fortnight), Mr. Jones (who supported Mr. Mulley's proposition), and Mr. Middlemass (who refused to undertake any responsibility should the meeting be adjourned). Eventually Mr. Mulley's proposition to adjourn the meeting for a fortnight was adopted by a majority of 19 to 17.

The first section of 500 Swan lamps for the Brighton Royal Pavilion is now being proceeded with, and the installation when complete will comprise nearly 2,000 of these lamps. For the preliminary trial Siemens' alternating current machines will be used, driven by a Robey engine of 40 H. P. nominal. As we have before stated, Mr. Magnus Volk is carrying out this large undertaking. At Hove also, in consequence of the satisfaction expressed at the temporary lighting of the new Town Hall last month, arrangements are pending for permanently lighting the building from a station about to be erected by Mr. Volk, at the request of influential residents.

We have received information that one of the most successful incandescent installations yet made is that in Willis's Rooms which were lighted up for the first time on Tuesday night by the Metropolitan (Brush) Electric Light and Power Company, Limited. The undertaking, owing to the confined space at disposal and to other local circumstances, was one of exceptional difficulty. The effect of the light, however, elicited warm expressions of approval from the numerous company assembled, and the work has been carried out to the entire satisfaction of Mr. Musgrave Heaphy, C.E., of the Phœnix Fire Insurance Company, who superintended the installation on Messrs. Willis's behalf. The existing chandeliers and brackets were utilised without any disfigurement of wall or ceiling.

At a meeting of the Aberdeen Town Council on Monday last the Lord Provost, in replying to a question, said that the last intimation he had about the Electric Lighting Bills was that there was still some room for hoping that the Board of Trade would yield to the representations of the various corporations. Rather than submit to the proposed regulations they, along with the other corporations, would withdraw their Bill. But they must go along with those corporations that had stood by them all through and fight this question with the Board of Trade upon one of the Bills. They would have the advantage of getting closer at the merits of this electric light.

At the same meeting an application by the Brush Electric Light and Power Company, Scotland, for permission to lay electric lines was remitted to the Gas and Lighting Committee to consider and report.

Since the failure of the Brush light at Aberdeen, on the first evening of its trial, Saturday, the 23rd December, owing to passing the current through the lamps the wrong way, and the breakdown of the engine on the 28th ultimo, the lamps have been run very steadily and satisfactorily. The three lamps in the Industrial and Art Exhibition (now being held in the handsome Town Hall buildings) light that hall about as perfectly and as agreeably as could be wished for, and every one agrees that there it is a great success. In the streets, with the exception of Castle Street, the lamps are placed too far apart. The globes are of clear glass, and the rays are complained of as too piercing and casting deep shadows. Besides these faults the lamps, which are by no means pretty in themselves, are stuck upon rude wooden poles of about 20 feet in height, and in such a way in some instances so as to throw the shadows towards the street and the light on the sides of the houses, where it is not wanted. We understand that the engine, which is an old one, has been lent by Councillor Duff, free of expense; that the town supply the coal and almost all the labour necessary to carry on the work, with the exception of a man experienced in trimming the lamps, &c.; and that the company have contracted with the town to rent their lamps, dynamo, wires, supply carbons, &c., for the small sum of 1½d. per hour per lamp. At present the lamps are burned from about 4 p.m. to midnight, or say, eight hours out of the twenty-four. There are sixteen lamps, so this means only 13s. 4d. per night to the town, which seems to please the Aberdonians, and if they are pleased no doubt more liberal constituencies would be highly delighted with such easy terms. We wish the Scottish Brush Company success in their northern undertaking, and compliment them on being more successful in Aberdeen than they were in Edinburgh.

The Glasgow College of Science and Arts.—After the distribution of medals, diplomas, &c., gained by the students during last year, Mr. Andrew Jamieson, the Principal, stated that the large number of 565 individual science pupils were attending the classes, and that the examinations showed the students of this college to have distinguished themselves more than in any former year. We congratulate Mr. Jamieson on the results attained, feeling sure that his efforts will show still greater success in the future.

Lectures.—In the course of last month Mr. Lant Carpenter delivered, before large and appreciative audiences in Forfar, Brechin and Arbroath, interesting lectures on "Electrical Signalling — The Telephone." Under the auspices of the Sunday Society he lectured on "The Telephone," in Queen's Rooms, Glasgow, on Sunday evening the 24th ult. Owing to unforeseen circumstances Mr. Shepherd, of Rossend Castle, had to proceed to Edinburgh before the meeting began. He, however, arranged to introduce the lecturer by telephone, and this he successfully accomplished to the delight of the audience. During the evening music, vocal and instrumental, was transmitted from Rossend Castle, 10 miles distant, and was clearly heard and warmly applauded by the large meeting.

New Telegraph Ship.—We are informed that Mr. W. F. Wardroper, at present in command of the telegraph steamer *International*, has been appointed to the command of the s.s. *Viking*, the new telegraph repairing vessel, which has been built for the Western & Brazilian Telegraph Company.

New Bill for the Regulation of Telegraph and Cable Companies in the U. S. of America.—By Mr. Joyce (Rep. Vt.).—It provides that every such company shall receive any message from any other telegraph company, and shall transmit and deliver the same in good faith and without discrimination, whether it shall relate to the business of the company offering it, or shall have been received or collected from other persons for transmission. Any company violating this provision shall be liable to a penalty of 500 dollars for every such violation. It also declares that any *employé* of any company who shall read, inspect, or examine any message, except such *employés* as must read it for the purpose of transmission or delivery, shall be deemed guilty of misdemeanour, and shall be liable to a fine of not more than 500 dollars, or be imprisoned not more than six months; provided, that this section shall not apply to any act done in obedience to any subpœna or any other legal process.

Electrical Appliances on the Great Western Railway.—The installation of the electric light at the Paddington station of the Great Western Railway has now been in operation for over 12 months, and during that period it has given general satisfaction. Mr. C. E. Spagnoletti's system of electrical signal "repeaters," which show the position of the signal-arm (in distant signals), whether "danger" or "all right" (or any intermediate position), are now in full operation. This arrangement indicates to the signalman who works the levers whether the signal has responded properly to the movement of the lever, and also whether the arm remains in the position to which it has been moved. At night, when the lamp is lit, an indicator shows whether the former remains alight or has become extinguished; in the latter case a bell is rung so as to warn the signalman. By a new arrangement, Mr. Spagnoletti has been enabled to effect the double indication of the position of the arm and the state of the lamp by means of one line-wire instead of two as at present. The same gentleman's electric locking system is working most satisfactorily both on the Great Western and also on the Metropolitan Railway. On double lines the starting signal for a train to proceed cannot be given by the signalman until it is unlocked by the signalman at the station in advance, and he cannot unlock it if the previous train has not arrived at the point which is fixed to be the clearing-point for that station. On single lines the arrangement is such that not only cannot one train follow another until the previous one has arrived, as on double lines, but the starting signal to let a train proceed in the opposite direction cannot be lowered until the train in the section arrives at the required spot authorised by the traffic superintendent, so that there can be no meeting or following of trains. Mr. Spagnoletti's system is different from the one generally adopted, namely, to have mechanical appliances and the men to work and check them: in the present arrangement on the Great Western Railway the mechanical appliances are worked by the men, but checked electrically by the train itself. This system is so elastic that it can be applied to all sorts of places and to all modes of working; it is cheap and not liable to derangement, and 12 months' working has proved its efficiency. An important piece of apparatus for preventing a signal being sent or received for a train to be allowed to go on over a drawbridge when the latter is open, has now been in use for the last 14 years and has worked perfectly; the apparatus in fact has never been touched since it was set up. Although this arrangement has not been yet applied in connection with the electrical locking of the signal lever it will probably be so before long.

Upon a Proposed Method of Producing Artificial Respiration by Means of a Vacuum Jacket.—Abstract from a paper read by Prof. A. G. Bell before the American Association for the Advancement of Science, August, 1882. "I propose to surround the waist of the unconscious patient by a rigid jacket, or drum, somewhat larger in diameter than his body. The apparatus can be reduced practically air-tight by a rubber band round the thorax, and another around the loins. Upon exhausting the air inside the drum, a practical vacuum is produced around the abdomen. Under such circumstances the pressure of the atmosphere forces air through the mouth and nose into the thorax, causing the depression of the diaphragm and consequent expansion of the abdomen. The alternate rarefaction and condensation of the air confined around the abdomen thus causes alternate inspiration and expiration."

American Telegraph Monopolies.—At a recent meeting of the directors of the Baltimore and Ohio Railroad Company, President Garrett congratulated them on the completion of the competing telegraph line between New York and Baltimore, and predicted the early extension of the system to embrace most of the business centres of the country.

Cable-Pooling.—Under this heading the New York *Herald* says:—Congress will, it seems probable, among other measures looking to the public interest, take in hand the violation by cable companies of the agreement exacted by the Government for the protection of the public, that there should be no amalgamation of companies or combination for the purpose of raising rates.

Telegraph for the West Side of Shetland.—A long correspondence has taken place between Mr. Garriock, of Reawick, Shetland, Mr. Laing, M.P., and the Postmaster-General, with reference to the proposal to extend the telegraph system to the principal fishing stations on the west side of Shetland, the curers and fishermen there being under great disadvantage, particularly in the herring-fishing season, when some hundreds of boats from ports on the east and west coasts of Scotland are engaged in that industry. The Post-office and Treasury decline to extend the line from Lerwick to Walls and Reawick unless a guarantee be given by the inhabitants of £255 for seven years, a total guarantee of over £1,700; while Mr. Garriock maintains that the line can be constructed for less than £1,000. It having been proposed to get a guarantee out of the herring brand fund instead of a money grant, Mr. Laing has communicated with Lord Rosebery, who writes that he has forwarded the communication to the new Fishery Board.

Insufficient Telegraphic Facilities.—At a meeting of the Falkirk Town Council held on Thursday last, the inadequate telegraphic communication with Falkirk was under discussion. It was unanimously resolved to memorialise the Postmaster-General on the subject. The purport of the memorial prays for direct telegraphic communication between Falkirk and Glasgow and Grangemouth. It was explained that much inconvenience is at present felt by the delay in all telegraphic messages to and from Glasgow, which have to go round by Edinburgh; and by all messages to Grangemouth from Falkirk having first to go to Edinburgh, thence to Glasgow, and again retransmitted to Grangemouth. A councillor remarked that a message by rail to Grangemouth would be much more quickly delivered than by wire. It was also resolved to solicit the aid of Mr. Ramsay, M.P., for the Falkirk burghs, in having the wishes of the Council given effect to.

Cable Fouled.—During the heavy gales of last week the Post-office cable Granton to Burntisland was twice fouled; first on Wednesday by the s.s. *German Emperor*, and second on the following evening by the barque *Bonâ Fide* from Almeira to Burntisland. The former vessel dragged the cable some distance before it brought her up, and so enabled her to enter the harbour. The latter did not clear her anchors till Friday afternoon. The cable does not appear to have suffered serious injury as communication remains uninterrupted.

Cable Repaired.—The Direct Spanish Telegraph Company, Limited, announce the repair of their Marseilles-Barcelona cable.

Proposed New Duty for Post-office Officials.—The Wick Chamber of Commerce at a meeting last week resolved to memorialise the Postmaster-General to instruct the "managers of the telegraph service of various fishing ports" to adopt in this country a similar mode of making known the presence of shoals of fish in the waters adjacent to the shores of this country.

NEW COMPANIES REGISTERED.

United Telephone Company of the River Plate (Limited).—Capital £200,000, in £5 shares. Registered office, 19, Great Winchester Street, E.C. Objects: To adopt two agreements of the 16th instant, the first between the Continental Telephone Company and T. R. Raleigh, and the second between Adolph Fels and T. R. Raleigh; also to carry on the general business of a telephone and telegraph company. Signatories: A. Wood, Godstone, Surrey, 20 shares; R. M. Cunningham, 114, Earl's Court Road, 20 shares; E. C. Blogg, 43, Alvington Crescent, Dalston; E. Cliff, 53, Upham Park Road; W. M. Crace, Loughton, Essex; T. W. Bischoff and J. H. Dodgson, 4, Great Winchester Street, 1 share each. The signatories are to nominate the first directors; qualification, 20 shares; remuneration, £500 per annum and one-tenth of dividend or bonus over £5 per cent. per annum upon paid up capital. Registered 16th instant by Bompas, Bischoff & Dodgson, 4, Great Winchester Street, E.C.

Electrical Rotary Brush Company (Limited).—Capital £100,000, in £1 shares. Objects: To purchase the letters patent, No. 2,562, dated May 31st, 1882, granted to Robert Farrington Honey, of 60, Strand, for "Improvements in the method or means of and appliances for communicating a rotary motion to brushes employed for various purposes, but specially for brushing hair." The purchase consideration is £15,000 in fully paid shares and £35,000 in cash. Signatories: E. Powell, 3, Lansdowne Terrace, New Wandsworth, 5 shares; P. W. Nazer, 38, Chancery Lane, 5 shares; C. H. J. Lewis, 5, Everton Terrace, N., 1 share; E. Farman, 32, Gresham Street, 5 shares; E. Butterworth, Hounslow, 1 share; T. Tarbuck, 11, Delverton Road, Kennington, 1 share; G. Burgess, 3, South Square, Gray's Inn, 1 share. Directing qualification: Shares or stock to the nominal value of £25. The first directors are—Major-General George Wolfe, the Hon. R. G. Molyneux, W. C. Breadalbane Annesley, Commissary-General J. Osberton Hamley, and Ernest S. Spencer. Remuneration: 100 guineas per annum in respect of each director, with an additional 200 guineas for the chairman. Registered 1st inst. by Percy William Nazer, 38, Chancery Lane.

OFFICIAL RETURNS OF ELECTRIC COMPANIES.

Standard Time and Telephone Company (Limited).—The return of this company, made up to the 24th ult., was filed on the 6th inst. The nominal capital is £100,000, in £1 shares. The number of shares taken up is 20,085. Upon 20,000 shares 18s. has been called, upon 50 shares the full amount has been called, and 4s. per share upon the remaining 35. The total calls paid amount to £18,057. Registered office, 19 and 21, Queen Victoria Street.

Patent Electric Gas Igniting Company (Limited).—The return of this company, made up to the 14th inst, was filed on the 20th inst. The nominal capital is £100,000, in £5 shares. 16,000 shares have been allotted and the full amount called thereupon. The calls paid amount to £69,752 10s., leaving £10,247 10s. unpaid. Registered office, 7, Queen Victoria Street.

Consolidated Telephone Construction and Maintenance Company (Limited).—The second return of this company, made up to May 8th, was filed on July 27th. The nominal capital is £300,000, in £1 shares. 154,165 ordinary shares have been taken and paid up and 45,835 shares have been allotted as fully paid to the vendors. Registered office, 6, Lombard Street.

South Staffordshire Electric Lighting Company (Limited).—The return of this company, made up to September 28th, was filed on October 10th. The nominal capital is £100,000, in £5 shares, but only 16 shares are recorded as taken up, and upon these nothing has been paid. Registered office, 33, Waterloo Street, Birmingham.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1882.

1895. "Electric lighting and incandescent lamps." P. M. JUSTICE. (A communication from abroad by A. Cruto, of Italy.) Dated April 20. 6d. This invention relates to incandescent lamps and to the combination and arrangement of parts by which these lamps may be advantageously manufactured, as also to the means employed for regulating the current.

2232. "Apparatus for generating electric currents." J. M. STUART. Dated May 11. 6d. Relates to that class of apparata (*sic ! ! !*) employed for the generation of electric currents, known as dynamo machines, and the invention consists of the combination and arrangement of parts as hereinafter set forth. The armatures are formed of soft iron cylinders of suitable dimensions, one end of each cylinder being closed by a plate attached to a suitable shaft supported in bearings and carrying an ordinary driving pulley. Opposite the first described cylindrical armature is a second plate with its shaft bearings and pulley, and attached to said plate are two additional cylindrical armatures, one of which passes within while the other surrounds the first cylinder. Although only three armatures are described, the system is applicable to four or even more. All the cylinders which are to form the armatures are wound longitudinally either with the ordinary wire or with a combination wire formed of a small soft iron core, around and insulated from which is wound copper wire. In this the preferred method each combination wire is in itself an electro-magnet. The plates carrying the cylindrical armatures are revolved in reverse directions, so that the currents cross each other in opposite directions. There is generated in this manner a combination of currents which proceed in opposite directions and greatly increase the power of the machine. Surrounding or partly surrounding the armatures are placed electro-magnets which may be of ordinary construction, but it is preferred to build them up of the combination wire before described. The armatures being made to revolve the currents generated are collected and carried to the desired places by means of the ordinary apparata now employed for that purpose. Fig. 1 represents a central longitudinal section of a machine with three revolving armatures. Fig. 2 represents a cross section of fig. 1. In the drawings the armatures are represented as being formed of soft iron bars or cores, A A¹, secured to end plate, B B¹, by bolts, C C¹. The bars or cores being held equidistant by means of two or more soft iron rings or segments, D D¹, upon which the ordinary copper or the combination wire before described, is wound. The bars or cores, A A¹, are arranged on the plates, B B¹, in such a manner that, when say at four points, the bars or cores, A A, are opposite the bars or cores, A¹, the intermediate bars or cores will be opposite or approximately opposite to the wire coils on the cylinder or cylindrical section next in order which it surrounds or by which it is surrounded. The field magnets, E E¹, are shown as being of soft iron wound at their sides with the ordinary or with the combination wire. The shafts, F F¹, carrying the plates, B B¹, and the ordinary driving pulleys, also carry the commutators, G G¹, which may be of any known and practical form and to, and from said commutators, the electric currents generated are conducted in the ordinary manner. In working the pulleys are driven in opposite directions.

FIG. I

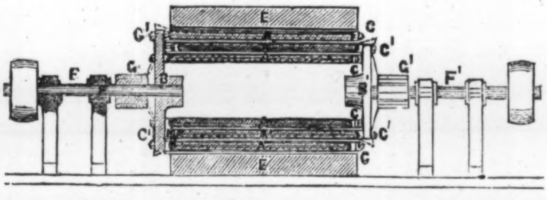
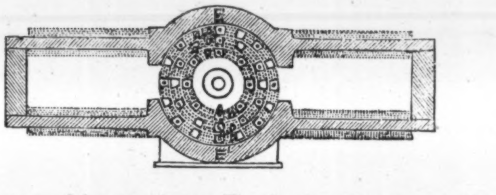


FIG. 2.



2233. "Electric lamps." J. M. STUART. Dated May 11. 4d. Relates to that class of electric lamps in which the light is produced and maintained in a vacuum. The invention consists of the application and combination of the herein-after described materials for the purposes specified. Into the opening of the globe in which the light is to be produced the inventor introduces through the stopper or plug two fine glass tubes, within which are sealed the preferably platinum wires which conduct the current. The wires do not extend the full length of the tubes, but terminate at a little distance from the interior ends of said tubes. The air in the globe is rarefied by the use of ether or other suitable substance, and is then exhausted from the globe, into which is then introduced a small quantity of carbonic acid, the air in the globe being again exhausted as perfectly as possible and the globe sealed. If a current of electricity be then passed through the globe a steady soft light will be given out from the small tubes, through one of which the current will enter and be then conducted to the other by attraction and condensation, the carbonic acid becoming gas by the action of the heat given out by the current in passing through the globe. If it is desired to have an incandescent carbon light, the inventor attaches to the extremities of the wires in the tubes a thin carbon fibre which he prefers should be animal carbon, and this may be conveniently and advantageously prepared from horse hair, which may be carbonised and bent in the usual manner.

2248. "Apparatus for measuring electric currents." T. VARLEY and H. B. GREENWOOD. Dated May 12. 6d. The object of this invention is to provide means for measuring, that is to say indicating and registering correctly, the amount or quantity of electricity supplied from any source for lighting or other purposes, so that any person using electricity may know the amount which has been supplied to him.

Eastern Electric Light and Power Company (Limited). -We learn that Mr. Walter Jackson has been appointed secretary of this company.

Direct Spanish Telegraph Company.—We are informed that the cable of this company between Marseilles and Barcelona is restored, and that telegrams for Barcelona and other places in Spain can again be sent by that route. Also that the company having acquired a special wire between London and Falmouth, the direct Spanish cable to Bilbao will, on and after January 1st, 1883, be worked direct from the company's station, 1, Leadenhall Street (corner of Gracechurch Street).

LATEST QUOTATIONS.

Authorised Issue.	Share.	Name.	Paid	Closing Quotations. Jan. 3	Business Done.
		ELECTRIC LIGHT.			
40,000	10	Anglo-American Brush Co.	4	7¼- 7¾	7½.⁹⁄₁₆.
		Do. Do.	10	11 - 14	14
30,000	5	Australasian Electric Light, Power & Storage Co.	3	½- 1	
24,900	10	British Insulite Co., Limited, "A" Shares	5	2 - 3	
30,000	5	Brush Electric Light & Power Co. (Scotland)	2½	½- 1	
25,000	5	Great Western Electric Light & Power Co.	2½	¼- ¾	
24,980	5	Hammond Electric Light & Power Supply Co.	2½	3 - 3½	3
40,000	5	Indian & Oriental Electrical Storage Works Co.	2	¾- 1	
172,500	1	Maxim-Weston Electric Light and Power Co.	1	⅜- ⅝	
40,000	5	Pilsen-Joel & General Electric Light Co.	2	1 - 1½	
..	..	South African Brush Electric Light & Power Co.	2½	¾- 1¼	
100,000	5	Swan United Electric Light Co., Limited	2	1¾- 2	
		TELEGRAPHS.			
2,116,400*l.*	Stk.	Anglo-American, Limited	100	49 - 50	
2,441,800*l.*	Stk.	Do. Preferred } Def'd. receiving no div. until	100	80½- 81½	80¾.1.80½.¾
2,441,800*l.*	Stk.	Do. Deferred } 6 p. c. has been paid to Pref.	100	18 - 19	18⅜.⅝
130,000	10	Brazilian Submarine, Limited	10	11¾- 12	12.11¹³⁄₁₆ xd.
16,000	10	Cuba, Limited	10	9¾- 10¼	
6,000	10	Do. 10 per cent. Preference	10	17 - 18	
13,000	10	Direct Spanish, Limited	9	6½- 7	
6,000	10	Do. 10 per cent. Preference	10	16 - 17	
65,000	20	Direct United States Cable, Limited, 1877	20	11¾- 12	11⅞
100,000*l.*	100	Do. 6 per cent. Debenture, repayable 1884	100	100 -103	
380,000	10	Eastern, Limited	10	11 -11¼	11⅛.11.¼
70,000	10	Do. 6 per cent. Preference	10	13¼- 13¾	
232,000*l.*	100	Do. 6 do. Debentures, repayable Oct. 1883	100	100 -103	
200,000*l.*	100	Do. 5 do. do. Aug. 1887	100	101 -104	
200,000*l.*	100	Do. 5 do. do. Aug. 1899	100	104 -107	
199,750	10	Eastern Extension, Australasia & China, Limited	10	11⅞- 12⅛	12⅛
320,000	100	Do. 6 p. c. Debentures, repayable Feb. 1891	100	108 -111	
500,000	100	Do. 5 p. c. (Australian Gov. Subsidy) Deb. 1900	100	104 -107	xd.
140,000	100	Do. do. registered, repayable 1900	100	104 -107	
100,000*l.*	100	Do. 5 per cent. Debenture, 1890	100	102 -105	
254,300*l.*	100	Eastern and South African Limited 5 per cent. Mort. Deb. Registered redeemable 1 Jan. 1900	100	102 -105	xd.
345,700*l.*	100	Do. do. do. To Bearer	100	102 -105	xd.
22,050	10	German Union Telegraph and Trust, Limited	10	10¼- 10¾	
163,390	10	Globe Telegraph and Trust, Limited	10	6⅜- 6⅝	6⁷⁄₁₆.⁹⁄₁₆
163,209	10	Do. 6 per cent. Preference	10	12 - 13	12¹⁵⁄₁₆.⅞ xd.
125,000	10	Great Northern	10	12⅛-12⅜	xd.
100,000*l.*	100	Do. 5 per cent. Debentures	100	100 -103	
31,200	10	India-Rubber, Gutta-Percha and Telegraph Works	10	29 - 30	
100,000	100	Do. 6 per cent. Debentures, 1886	100	100 -103	
17,000	25	Indo-European, Limited	25	31 - 32	
38,148	10	London Platino-Brazilian, Limited	10	3¾- 4¼	
12,000	10	Mediterranean Extension, Limited	10	1½- 2	
8,200	10	Do. 8 per cent. Preference	10	6 - 8	
9,000	8	Reuter's, Limited	8	12¼- 12¾	
280,000	Stk.	Submarine	100	250 -255	
58,225	1	Do. Scrip	1	2¼- 2½	
4,200	Cert.	Submarine Cables Trust	100	104 -108	
37,350	12	Telegraph Construction and Maintenance	12	31½- 32½	31⅝.⅞
150,000	100	Do. 6 per cent, Bonds, 1884	100	100 -103	
186,750	5	Do. 2nd Bonus Trust Cert.	5	1⅜- 1⅝	1⁹⁄₁₆.⁷⁄₁₆.½
30,000	10	West Coast of America, Limited	10	4¾- 5¼	
150,000	100	Do. 8 per cent. Debentures	..	..	
69,910	20	Western and Brazilian, Limited	20	8 - 8¼	8⁷⁄₁₆
200,000*l.*	100	Do. 6 per cent. Debentures "A" 1910	100	104 -107	
2,500	100	Do. 6 p.c. Mort. Deb. series B of '80, red. Feb., 1910	100	98 -101	
1,500	$1,000	Western Union of U. S. 7 p.c. 1 Mort. (Building) Bds.	$1,000	122 -126	
1,030,000*l.*	100	Do. 6 per cent. Sterling Bonds	100	102 -105	
88,321	10	West India and Panama, Limited	10	1¼- 1½	
34,563	10	Do. 6 per cent. 1st Preference	10	7 - 7½	
4,669	10	Do. 6 do. 2nd do.	10	5½- 6	
		TELEPHONES.			
154,165	1	Con. Telephone & Maintenance, Ld. Nos. 1 to 154,165	1	⅝- ⅞	
200,000	1	Oriental Telephone Co., Nos. 100,000 to 300,000	½	⅝- ⅞	
100,000	5	United Telephone Co.	5	10¾- 11¼	

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